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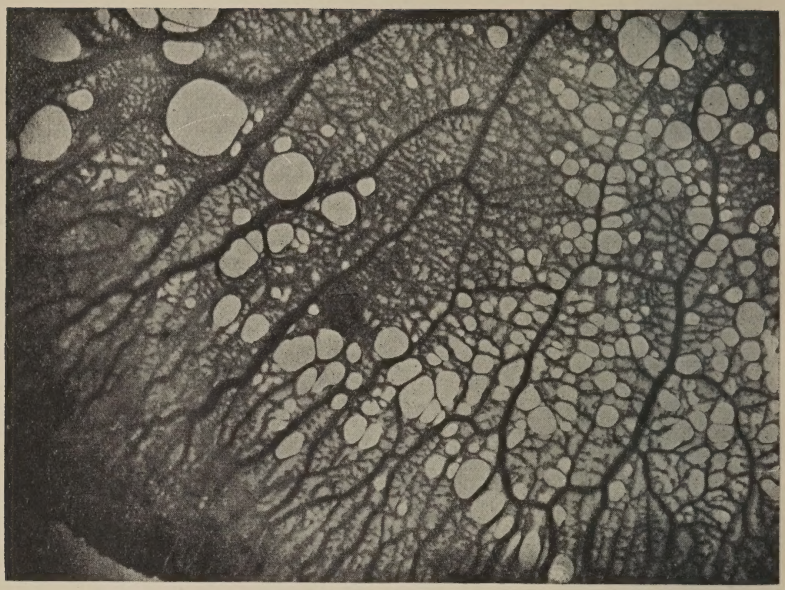
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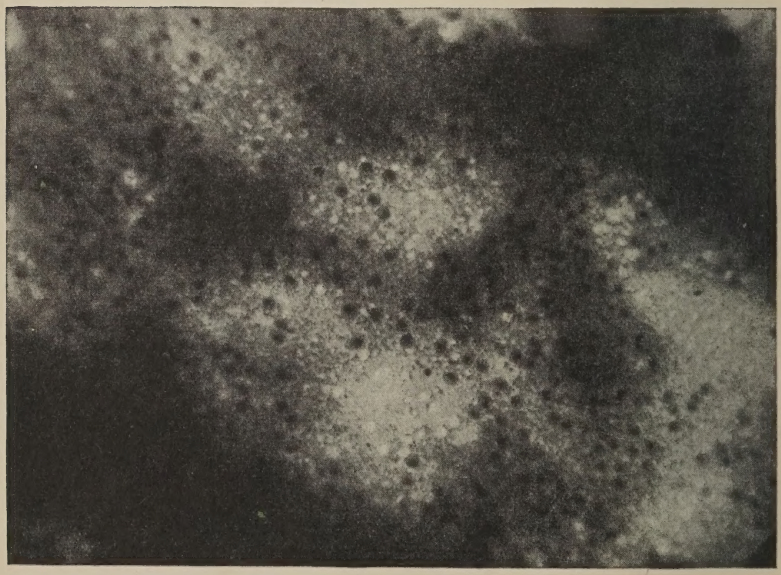
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BADHAMIA UTRICULARIS Berk.
Plasmodium spreading on glass, magnified 15 times.



Part of the same, showing nuclei, magnified 400 times.
(*Photo. by* W. T. LISTER.)

British museum (N.H.)-- Dept. of botany.

A MONOGRAPH

OF THE

MYCETOZOA

A DESCRIPTIVE CATALOGUE

OF THE SPECIES IN THE

HERBARIUM OF THE BRITISH MUSEUM

BY

ARTHUR LISTER, F.R.S., F.L.S.

THIRD EDITION, REVISED BY

GULIELMA LISTER, F.L.S.

WITH TWO HUNDRED AND TWENTY-THREE PLATES
AND FIFTY-SIX WOODCUTS

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PREFACE TO FIRST EDITION

THE collection of specimens of Mycetozoa in the Herbarium of the British Museum has been greatly increased in recent years. The additions include the large collection of the late C. E. Broome, bequeathed by him to the Museum, and that of H. W. Ravenal, purchased from his widow.

It was necessary to make a critical examination of the whole of the materials in the Herbarium. Mr. Arthur Lister, who has devoted much attention to these organisms, was fortunately able to undertake this work; and he agreed at the same time to prepare a monograph of the whole class based on this examination.

This volume, the result of his labours, contains descriptions not only from the specimens in the Museum, but also from types in various public and private Herbaria, and from his own rich collection. Mr. Lister has generously presented a large series of specimens to the Museum, so that the Herbarium now contains types of all the species described by him in this monograph.

The volume is fully illustrated with plates mechanically reproduced from faithful water-colour drawings by the author and by his accomplished daughter, to whom in the Introduction Mr. Lister acknowledges his obligations.

WILLIAM CARRUTHERS.

November, 1894.

993195

PREFACE TO SECOND EDITION

THE widespread interest aroused in the study of the Mycetozoa by the publication of Mr. Lister's work has found expression in a large influx of material, the study of which has led to the recognition of new genera and species, and an extension of our knowledge of the geographical distribution of known forms; and has in some instances rendered necessary a re-consideration of views previously held. These considerations, together with the revision of the nomenclature in conformity with the International Rules, practically necessitated re-writing the book when the need arose for a new edition. In the preparation of this edition Miss Lister has continued the work in which she was for so long and so intimately associated with her father, and for which she is so eminently well equipped.

A special feature of the second edition is the replacement of the collotype plates by a new and more complete series. A large proportion have been reproduced by the three-colour process, and greater justice has thus been done to the original drawings by Mr. and Miss Lister, than was possible by the method of reproduction formerly employed; that so large a proportion are reproduced in colour is due to Miss Lister's generosity. A bibliography has been added, and also a short glossary which supplements the explanation of terms given in the Introduction.

In order to make the National Collection as complete as possible, Miss Lister is generously presenting a large series of specimens to the Museum.

A. B. RENDLE.

DEPARTMENT OF BOTANY,
November, 1911.

PREFACE TO THIRD EDITION

THE present edition embodies a careful revision of the text in the light of the increase in our knowledge of the Mycetozoa during the interval since the publication of the second edition.

Three additional genera have been described, and forty-six additional species ; some of the latter are, however, due to the promotion of varieties to the rank of species. Twenty-two new plates have been added, eight of which are coloured.

A. B. RENDLE.

DEPARTMENT OF BOTANY,
January, 1925.

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NOTE TO THE SECOND EDITION

It was my father's intention to have brought out the second edition of this Catalogue himself, and the book in its present form has been largely compiled from material collected by him. In the many alterations now introduced, his views have been for the most part embodied.

I had the privilege of being associated with him both in the preparation of the first edition and in the work undertaken in anticipation of the second. In bringing this edition to completion since his death in 1908, I have endeavoured to follow the conclusions arrived at in discussing with him the different points as they arose.

In the first edition of the present work the custom was followed, by which the first authentic specific name published under the genus in which the species now stands takes precedence of all others. When the Rules of Nomenclature were revised in 1905, it was agreed to follow in this respect the 'Laws of Botanical Nomenclature', drawn up by Alphonse de Candolle in 1867, namely, to adopt the earliest specific name under whatever genus it may have been published; and at the recent International Botanical Congress at Brussels (1910) it was decided that the starting-point for these names, as well as for those of the genera of *Mycetozoa*, should be the 'Species Plantarum' of Linnaeus, published in 1753. This principle was observed by Prof. T. H. Macbride in the compilation of his 'Slime-Moulds of North America', and the results of his researches, and moreover, his friendly correspondence, have been of much service to me in making the numerous changes in familiar names in the present edition of the British Museum Catalogue necessitated by the adoption of a new rule of nomenclature. I have traced the history of the species in the library of the Department of Botany at the Museum, a task which in the former edition was kindly undertaken by Mr. Carruthers, who was then at the head of the Department. I cannot be too grateful to Dr. Rendle and the present staff of the Department for their unfailing kindness and courtesy in facilitating the labour involved in this part of the work.

In the introduction to the first edition my father expressed his thanks to those from whom he had received assistance, and I here quote his own words: 'I offer my grateful acknowledgements to those through whose courtesy I have been enabled to study the various herbarium specimens that have come under my notice; to the Director of the Royal Gardens at Kew for giving me special facilities for investigating the

collection under his care, which includes Berkeley's precious series, containing a great number of original types from India, New Zealand, and America, that supplied Rostafinski with a large part of the material introduced into the Appendix to his Monograph. These types are to a large extent duplicated in Broome's and Ravenel's collections in the British Museum. To Professor Bayley Balfour I return my thanks for much friendly assistance and for the opportunity of inspecting the specimens in the Royal Herbarium at Edinburgh, including Greville's collection and an almost complete set of type examples supplied by the late Professor de Bary; to Professor van Tieghem for the inspection of the collection of the Paris Museum; to Professor A. Blytt for an opportunity of examining the most important types in the Museum at Christiania; to Dr. Boerlage for giving me access to the Leyden collections; and especially to Graf zu Solms-Laubach for the privilege afforded me of inspecting de Bary's invaluable collection at Strassburg, containing a large proportion of the type specimens referred to by Rostafinski in his original Monograph; to Dr. Rex, of Philadelphia, for a nearly complete series of the species found in the United States of America, now represented in the British Museum collection, and for the communication of his views on a group to which he has devoted many years of careful research. I am also grateful to my friend Professor Farlow for many valuable specimens and useful suggestions; and to Professor Macbride, of Iowa, and Mr. Morgan, of Ohio, for a fine series of the *Mycetozoa* from their respective districts; also to Dr. Haviland for specimens of great interest from Borneo. Mr. Camm, of Smethwick, and Mr. Saunders, of Luton, have supplied me with many scarce British species; and to Mr. Phillips and Mr. Massee I am obliged for kindly entrusting me with their collections for examination.'

I should like to add my grateful thanks to those who, since the publication of the first edition, have greatly assisted both my father and myself by sending us specimens, as well as by their correspondence.

Dr. W. C. Sturgis, of Colorado Springs, has, for fourteen years, been a fellow-worker on whose friendly co-operation we could always depend; Dr. Jahn, of Berlin, has generously placed the results of his work on the life-history of the group at our disposal. In studying the distribution of the different species we have been greatly indebted to the collections made by the Rev. W. Cran and also by Professor Raunkiaer in the West Indies, by Dr. R. E. Fries in Sweden and Bolivia, by Professor Penzig in Java, and by Mr. Hugo Bilgram in Pennsylvania. The observations of our friend Mr. Petch on the *Mycetozoa* of Ceylon have been of great value, and our knowledge of those of Japan has been much increased by the

unwearied labours and graphic correspondence of Mr. K. Minakata, from whom we have received nearly three hundred specimens. The numerous gatherings made by Dr. C. Torrend in Portugal are the first examples of this group recorded from that country and have been kindly sent us for inspection. Dr. Čelakowsky has presented us with a valuable collection of his Bohemian gatherings ; we have also had the advantage of receiving many Swiss specimens from our friend Professor Hans Schinz, of Zürich, and, recently, from M. Meylan from the Jura Mountains. There are many others whose names I have not mentioned to whose contributions we have been greatly indebted.

I should like to repeat on my own account the acknowledgement given above to Professor Farlow for his continued assistance and sympathy, and to Mr. James Saunders for his constant assiduity not only in reporting his own investigations but in arousing the interest of others in the subject.

I cannot close without saying how invaluable it has been to me to have the counsel and experience of my brother Mr. J. J. Lister to rely on in continuing our father's work.

The plates at the end of the volume are reproductions of water-colour drawings made under the camera lucida by my father and myself, and are here reduced to half the diameter of the originals.

G. LISTER.

NOTE TO THIRD EDITION

Since the publication of the second edition of this Catalogue in 1911 I have received invaluable assistance from correspondents both old and new. The Rev. W. Cran in Aberdeenshire, M. Ch. Meylan in Switzerland, and Mr. K. Minakata in Japan, have continued to send many interesting specimens. Mr. A. R. Sanderson in Malaya, and the late C. O. Farquharson in South Nigeria, have given much valuable information on the habitats of Mycetozoa in the tropics. The collections made by Mr. W. N. Cheesman in Australia and New Zealand, by Miss A. V. Duthie in the Cape Province, and Professor M. Brandza in Roumania, have extended our knowledge of the range of many species. To Professor Brandza, students of Mycetozoa are especially indebted for the remarkable fine series of Roumanian specimens he has generously distributed. Mrs. Stelfox, Miss M. Rea, and Mr. W. F. Gunn have done much to increase our information with regard to Mycetozoa in Ireland. Mr. N. G. Hadden in the west of England, Dr. W. T. Elliott in Warwickshire, Mr. H. J. Howard in Norfolk, and the Rev. P. J. Alexander in Surrey, have supplied me with very interesting field notes and specimens from their respective districts.

To Dr. Rendle and the staff of the Botanical Department of the British Museum I am indebted for much help in the preparation of the present edition. Mr. J. Ramsbottom has done me great service by reading the proofs and offering many useful suggestions. To these and to many other correspondents and friends who have aided me I offer my sincere thanks.

G. LISTER.

INTRODUCTION

The Mycetozoa as described in the present work are characterized by having spores which on hatching in water give rise to amoeboid bodies, the swarm-cells or zoospores; these assume a flagellate form, divide, change to amoebulae, and, after further division, unite in pairs as gametes to form zygotes; the zygotes grow by feeding into a plasmodium exhibiting an internal rhythmic circulation; from this vegetative stage the aerial spore-bearing bodies, sporangia or sporophores, are eventually formed.

By the earlier naturalists these organisms were regarded as fungi from the resemblance some of the sporangia bear to minute puff-balls. Apparently the first undoubted reference to one of them is made by Panckow (25), who in 1654 figures and briefly describes what is now known as *Lycogala epidendrum* under the name *Fungi cito crescentes*. Micheli (23), in 1729, brought recognition to the group by describing and illustrating several of the genera amongst which *Mucilago* is distinguished as passing through a 'mucilaginous stage'. During the next hundred years considerable advance was made in identification of the varied forms of mature sporangia, and a number of genera and species of Mycetozoa were described, the results of which were ably summarized in systematic works on fungi by Persoon (26), and later with wider scope by Fries (8). As the result of careful observations made in the field, Fries realized the importance of the plasmodium stage in the development of the group, which he emphasized by establishing the sub-order, Myxogastres, for its reception, while retaining it among fungi in the order Gasteromycetes. In 1833 Wallroth substituted the term *Myxomycetes* (Schleimpilze, slime-fungi) for the older name, and this came to be the designation generally accepted. It was de Bary (1) (1860–4) who introduced the modern view of the position of the Mycetozoa (or Fungus-animals, as the name he gave these creatures may be translated); he cultivated the spores and saw them give birth to a naked mass of protoplasm, the swarm-cell; he watched the swarm-cells swim about, divide, and later withdraw their flagella and creep as amoebulae; he inferred that it was by the union of such amoebulae the young plasmodia abounding in his cultures were formed; he observed the rhythmic circulation of the plasmodium and described the development and structure of the sporangia. Cienkowski (1863) saw the union of amoebulae and first gave the name

plasmodium to the resulting mass of naked protoplasm (4); he also watched the ingestion of solid food by the plasmodium (5).

Under the heading Mycetozoa, de Bary retained the term Myxomycetes for the section so named by Wallroth, but linked with it a small group of simpler organisms, the *Acrasieae* of Van Tieghem (*Sorophora* Zopf). In this group the spores produce swarm-cells which do not pass through a flagellate stage. According to the observations of Skupienski (31) in *Dictyostelium*, a genus of the *Acrasieae*, the swarm-cells, after feeding on bacteria, fuse in pairs to form zygotes; these become massed together and unite to form a temporary plasmodium preparatory to building up a sporangium: the latter consists of a septate stalk crowned by a naked cluster of spores. It would appear that the 'plasmodium' in this case is associated only with spore-production, and is hardly comparable with the vegetative plasmodium with rhythmic circulation characteristic of the main mass of Mycetozoa; the name *Euplasmodida* was applied by Delage and Hérouard to the main group of Mycetozoa, thus emphasizing one of the chief characters which distinguishes it from the *Sorophora* (22, p. 39).

Rostafinski, the pupil of de Bary, produced (1875) an elaborate and fully illustrated Monograph of Mycetozoa (Sluzowce Monografia), which at once took its place as the classic systematic work on the subject. He followed de Bary in the view that the formation of a plasmodium indicates a wide separation in the natural position of the *Myxomycetes* from the fungi, but he suppressed that name entirely, adopting de Bary's class name *Mycetozoa* in its place; at the same time, he admitted the genus *Dictyostelium* into his Monograph, and excluded *Ceratiomyxa*. The present book deals only with the Euplasmodida, the higher Mycetozoa, but in other respects follows mainly the arrangement of families and genera given by Rostafinski. The work of later writers on Mycetozoa will be referred to in connexion with the more detailed account of the life-history.

The Mycetozoa may be divided into two sections, the *Endosporeae*, in which the spores are developed within a spore-case or sporangium, and the *Exosporeae*, containing a single genus, *Ceratiomyxa*, in which the stalked spores are borne on the surface of gelatinous bodies, the sporophores.

ENDOSPOREAE. Spore and swarm-cell.—The spores of the *Endosporeae* are usually spherical when moist; their size is so uniform as to afford a valuable character for classification; should they be found to vary much in size within a sporangium it may be concluded that conditions of development have been unfavourable and the spores are not normal. The spore-wall is a firm membrane composed

of a substance allied to cellulose (33), and consisting of two layers, the inner hyaline, the outer variously coloured, and marked with minute warts or ridges ; a thinner area where dehiscence takes place is often evident.

The spores while remaining in a dry state retain their vitality for several years. The length of time that elapses before the germination of the spore after it has been placed in water varies from a few hours to several days according to the species, and often in different gatherings of the same species. Observations on the darker spores of *Stemonitis fusca* showed germination after nine or twelve hours, while in the pale-spored variety it occurred in twenty-eight minutes. In *Reticularia Lycoperdon* it usually takes place in less than an hour in fresh gatherings ; spores from a specimen which had



Fig. 1.—*Didymium difforme* Duby.

a. Spore.

b. Swarm-cell escaping from the spore-case.

c. Newly hatched swarm-cell containing a nucleus and three vacuoles.

d. Flagellated swarm-cell.

e. Swarm-cell, with two vacuoles containing bacteria, and produced at the posterior end into pseudopodia, to one of which a bacterium is attached.

f. Amoeboid swarm-cell.

Magnified 720 times.

Fig 1.

been stored for nearly three years began to germinate in four hours after moistening, and in twenty hours the contents of nearly every spore had emerged.

The spore-wall is ruptured by the swelling of the contents, which slowly emerge and lie as a nearly pellucid globule by the side of the empty spore-case (fig. 1, *b*, *c*).* After remaining quiescent for a few minutes amoeboid movements begin to take place, and shortly afterwards a flagellum is produced. This is at first a somewhat tentative process, and the flagellum is frequently withdrawn ; but within a quarter of an hour it acquires its full length of about 15 μ, and by its lashing strokes the swarm-cell swims off with a dancing movement. At this stage the cell is pyriform ; the interior protoplasm

* Pinoy (27, 28) considered that the presence of certain bacteria was necessary for the germination of the spores of Mycetozoa. This view is rejected by Skupienski (31, 32), in whose experiments the spores of *Didymium nigripes* germinated in distilled water in a few hours, when the possible action induced by the growth of bacteria adhering to the spore-walls would have been reduced to a minimum. Experiments by Buller, and Constantineanu (6) with the spores of other species of Mycetozoa gave similar results.

is granular and contains a contractile vacuole, and often one or more vacuoles in addition which do not usually show contraction. At the narrow end is situated the nucleus, which can easily be recognized by its lighter and more homogeneous appearance and central nucleolus (fig. 1, *d*).. The nucleus does not alter its position, though constant movement is observed among the constituents of the granular part. Connecting the nucleus with the base of the flagellum is a bell-shaped tract free from granules, which takes when stained a rather darker colour than the surrounding cytoplasm.* In addition to the dancing motion, which is maintained as long as they are free in the water, the swarm-cells when they come to rest exhibit movements of an amoeboid character, and spread with an irregular outline ; or they assume a linear form and creep over a level surface with a snail-like motion, the flagellum being extended in advance. In this position the movement of the interior protoplasm is seen to advantage. In the large swarm-cells of *Amaurochaete fuliginosa* it may almost be described as circulation, the granules passing from one end to the other in constant flow. After a time the creeping movement is again exchanged for the dancing. In all cultivations of germinating spores, if the food-supply is insufficient, the swarm-cells, after a short period of activity, withdraw the flagellum and become encysted in a globular form (the *microcysts* of Cienkowski). On being dried and re-wetted, the contents burst the membranous cyst-wall, which remains as an empty hyaline sac, and emerge to resume their activity. If bacteria are introduced into a cultivation of swarm-cells, they are seen to be laid hold of by slender pseudopodia extended from the posterior end of the body where they are enclosed in a digestive vacuole (fig. 1, *e*). Several bacteria are brought in turn to the same chamber, or fresh captures are conveyed into one or more additional vacuoles. The protrusion of pseudopodia usually ceases for a time after such ingestion, and the hinder end of the swarm-cell takes a rounded form. In the course of an hour or two the bacteria are assimilated, and the digestive vacuoles disappear. Unicellular algae and inorganic matter are sometimes taken in, which are subsequently discharged. Both ingress and egress are observed to take place only at the posterior end (20).** De Bary, to whom this mode of feeding was unknown, considered that the swarm-cells obtain nutrition entirely from matter in solution (2, p. 452), and it may be that they are to some extent nourished in this manner.

Division of the swarm-cells begins a few hours after they leave the spore-case, and is many times repeated in the

* *Verbindungsstück*, Plenge (30), *Geisselglocke*, Jahn (13).
** This process was first described by Saville Kent (17).

course of the three or four succeeding days. The process begins with the withdrawal of the flagellum and the swarm-cell taking a spherical form.* The nucleus then divides by karyokinesis ; the swarm-cell becomes ellipsoid, and later a constriction appears in the middle. As bipartition proceeds the nuclear plate divides and the two halves separate, the connecting achromatic fibres being discernible. The daughter-nuclei at length retreat to the opposite poles of the swarm-cell, which in about a quarter of an hour from the beginning of the process of constriction is completely divided (fig. 2). A flagellum is in a short time produced by each daughter cell, which then assumes the original form of the parent. Jahn has shown that the bell-shaped tract crowning the nucleus is formed again after mitosis from the spindle fibres of the



Fig. 2.—*Amaurochaete fuliginosa* Macbr.

a to *f*. Successive stages in bipartition of swarm-cell, accompanied by the division of the nucleus by karyokinesis. Magnified 1,200 times.

Drawn from stained preparations in Canada balsam.

Fig. 2.

dividing nucleus, and that the flagellum is produced from its apex (13, p. 89).

After a time the swarm-cells withdraw the flagellum, and creep about as amoebulae. They divide repeatedly and then, after collecting in groups, begin to unite in pairs as gametes to form zygotes, their nuclei also uniting (16). It has been observed that in this union the gametes do not fuse indiscriminately with one another, but appear to exercise a selective faculty, suggesting that although outwardly similar they possess some primitive sexual distinction (31, p. 61).

Skupienski describes an experiment in which he isolated a single spore of *Didymium nigripes*, and from its offspring obtained, by suitable nutrition, abundant amoebulae which united in pairs to form zygotes, from which were produced plasmodia, and, eventually, a group of healthy sporangia. By

* Skupienski describes a division of flagellate swarm-cells by longitudinal fission, preceded by the division of the flagellum and the nucleus (31, p. 60).

a still more delicate experiment, several times repeated, he was able to isolate in one case a single flagellate swarm-cell, and in another case a single amoebula; although both swarm-cell and amoebula continued to divide and appeared healthy for a time, in neither case did they form zygotes or plasmodia. From this he infers that a single spore is capable of producing both kinds of gametes, and also that the presence of both kinds is needful for the formation of zygotes (31, p. 63).

The Plasmodium.—The zygotes when they begin to feed are called plasmodia. They grow rapidly, for they now have the faculty of ingesting unpaired amoebulae which are conveyed into large digestive vacuoles and there dissolved and

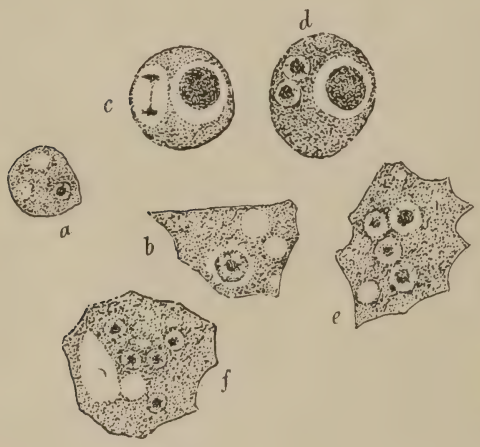


Fig. 3.

Fig. 3.—*Didymium squamulosum* Fries.

a. Amoebula or gamete.

b. Zygote with a single large diploid nucleus and several vacuoles.

c. Zygote or young plasmodium with a single nucleus undergoing mitotic division, and a large digestive vacuole containing the remains of an amoebula.

d. Young plasmodium with two resting nuclei, and a digestive vacuole containing an amoebula.

e, *f*. Young plasmodia with four and five nuclei respectively.

Magnified 930 times.

From stained preparations lent by Dr. Jahn.

absorbed; by this characteristic a zygote may be distinguished from a gamete in cultures under the microscope; the young plasmodia also fuse readily with one another when they come into contact, their nuclei remaining separate. Several of the phenomena which are met with in the swarm-cell may be seen on an extended scale in the plasmodium. The latter is endowed with power of locomotion, and advances over the substratum with a creeping movement in search of food. If a small plasmodium has been induced to creep on to a glass cover-slip, and is protected in a moist chamber it can be easily examined microscopically. The interior substance is seen to consist of granular protoplasm, containing numerous nuclei and vacuoles. The vacuoles vary in size, and frequently contract and discharge their contents, which are either watery or contain refuse matter. The movements in the interior of the swarm-cell are extended into a systematic circulation in the plasmodium,

which spreads in a network of veins with a few principal channels. Through these the granular protoplasm streams in a rapid torrent which gradually comes to a pause in the space of a minute and a half to two minutes, and then immediately reverses its course. A rhythmic flow is thus maintained backwards and forwards at nearly equal intervals, but always of somewhat longer duration in the direction in which the plasmodium is creeping. The flow is continued from the larger to the smaller veins which branch with increasing intricacy till they are lost in the broad tumid margin of the advancing plasmodium (*see Frontispiece*). The whole is invested by a layer of hyaloplasm devoid of granules but merging imperceptibly into the inner granular part. The hyaloplasm exhibits amoeboid movements, projecting and withdrawing pseudopodia, and is unequal in thickness over different parts; it is generally abundant at the advancing margin. The hyaloplasm appears to be a more firm condition of the protoplasm assumed when exposed on the surface. How far it may have a relation to the rhythmic streaming of the plasmodium, or what causes that movement, has not been ascertained. By means of this circulation all parts of a plasmodium are kept in communication. The track where a plasmodium has passed is marked by a double line of discharged refuse matter, and thus a map is left showing where it has been.

The description given above applies to plasmodia which creep over dead leaves or the surface of logs or woody fungi.* Those which inhabit the interior of rotten wood usually emerge only at the time of spore-formation, and then appear as cushion-like masses or as scattered globules. The plasmodia of the *Calcarineae* contain granules of calcium carbonate (designated 'lime'). The granules vary in abundance in different species, being small and inconspicuous under the microscope in some, while in the opaque white plasmodium of *Diderma hemisphericum* they appear like crowded glass beads 2μ or more in diameter, and tend to impede the streaming movement. The colour of the plasmodium is usually either white, yellow, or pink; in some cases it is purple or green; it is generally constant in each species.

A series of observations was made by Pinoy (29) on the plasmodium of *Didymium nigripes*. This is normally pale grey in colour, but, in his cultures from spores, he obtained strains that were yellowish and blackish-violet respectively, as seen by transmittent light: although both the light and dark plasmodia appeared to be perfectly healthy, they

* *Hymenobolina* is exceptional among Mycetozoa in having small plasmodia which exhibit no rhythmic circulation of protoplasm; they occur on living lichens and dead wood and are usually almost stationary in habit.

produced no sporangia. He then brought fragments of the two strains together in one culture, and obtained from their union a grey plasmodium which formed normal sporangia in ten days. Pinoy suggested that the two strains of plasmodium might possess a kind of sex differentiation, and their union might be regarded as a process of conjugation. Since the publication of Pinoy's observations, however, Jahn has proved that it is at an earlier period of the life-history that the sexual stage occurs, namely, when the amoebulae fuse in pairs to form zygotes. Pinoy's results are interesting in showing how an increase of vigour may be brought about by the blending of different strains of plasmodium.

De Bary's statement that ' union never takes place between plasmodia of different species ' is fully borne out by the experience of others, and no satisfactory evidence to the contrary has been obtained (2, p. 426).

The food of plasmodia varies according to the species. Those which live among dead leaves spread with veins which are brown from the incorporation of decayed vegetable matter. The plasmodium of *Badhamia panicea* thrives on the inner bark of felled elms, and is difficult to discern on the red-brown substratum owing to the fragments of bark with which it is densely charged ; it becomes pure white by the rejection of enclosed matter before fruiting. Occasionally the question of food is somewhat obscure : for example, the plasmodium of *Amaurochaete fuliginosa* rises in cushions from half an inch to two inches in diameter from the hard and apparently sound wood of Scotch firs ; that of *Stemonitis splendens* may also be found emerging from the sawn surface of fir stumps which show no sign of decay, and covering an area of six to seven square inches. Whatever solid matter these plasmodia may have ingested has been parted with before leaving the wood, but it appears possible that their food was absorbed in a state of solution. The plasmodium of *Badhamia utricularis* is one of the few we are acquainted with that feed on living fungi. It is capable of being cultivated without limit on *Stereum hirsutum* and allied species, and can be observed under the microscope to dissolve fungus hyphae as the hyaline border of a wave of the yellow plasmodium advances over them. Plasmodia are strongly attracted to suitable food, which they perceive apparently by contact only. They avoid harmful substances. If fresh food is placed so as to touch one point of a plasmodium widely extended in a network of veins, a stimulus is sent to the remotest parts, the streaming of the circulation is quickened towards the food, and on it in a few hours the whole plasmodium concentrates.

Plasmodia have often been cultivated successfully on artificially prepared nutritive media (see Constantineanu (6),

Pinoy (29)). Experiments made by Miss Greenwood and Miss Saunders show that the digestive vacuoles of the plasmodium, in which sclerotium-cysts and other proteids are dissolved, contain an acid fluid, whereas the reaction of the plasmodium as a whole is alkaloid (9). Pepsin was found by Krukenberg to be present in the plasmodium of *Fuligo septica* (18).

In their vegetative stage plasmodia require moist surroundings ; in exceptional cases they have been found not only to feed under water but to form sporangia there ; usually it is moist and not wet places that form their feeding grounds. Such places are apt to be shady, and it has been said that plasmodium avoids light. It has been seen, however, that cultures of *Badhamia* kept moist under a glass cover, thrive equally in light or shade, and even when exposed to direct sunlight.

The Sclerotium.—Plasmodia are able to withstand exposure to dry weather or great cold, by passing into a *sclerotium* or resting stage. In some cases, however, the change into sclerotium occurs when water and apparently food material are present, and the cause is then difficult to discover. As the plasmodium of *Badhamia utricularis* becomes dry, the streaming movement gradually ceases, and the granular protoplasm becomes aggregated in discrete masses surrounded by hyaloplasm ; the refuse matter is thrown out, and a membranous cyst-wall forms round each mass, which also includes 10 to 20 nuclei ; the cysts become packed into thick agglomerations of irregular shape, drying to a horny consistency (19). The changes of outline seen in the maturing sclerotia cannot be merely the effect of shrinking from drying, and as under the microscope we frequently observe the cysts along the margin of a forming sclerotium creep among each other with amoeboid movement, it is probable that the change in shape of the mass may thus be accounted for. The sclerotium of this species can revive after preservation in a dry state for three years, on being placed in water. Recently formed sclerotium resumes the creeping condition in a few hours, but after remaining dry for more than a year it requires to be kept wet for some days before movement begins again ; the cyst-walls are then absorbed, and their contents coalesce. It frequently happens that parts of old sclerotia are incapable of resuscitation, but they afford a pabulum for the newly awakened plasmodium, through whose veins the cysts may be seen to be carried along and broken up. The sclerotium of *Didymium squamulosum* is sprinkled over with a deposit of crystals of lime, and after being revived the cyst-walls are not dissolved as in *Badhamia*, but remain as empty hyaline sacs when the contents have crept out. The formation of sclerotium in plasmodia inhabit-

ing the interior of rotten wood is less easy to follow, but it is probably of frequent occurrence. A plasmodium of *Stemonitis fusca*, cultivated from spores in a moist chamber, passed into the resting state a few days after it had formed, spreading in a single layer of crowded cysts on the surface of the glass. This sclerotium was dried and re-wetted, when it revived, and the cyst-walls were dissolved ; the cultivation was conducted with pure water, with no attempt to supply nourishment, and the plasmodium returned to the encysted condition in about twenty-four hours ; it was again dried and again revived, but afterwards it reassumed the sclerotium state, from which it could not be reawakened.

Nuclei.—As a plasmodium grows the nuclei within it increase

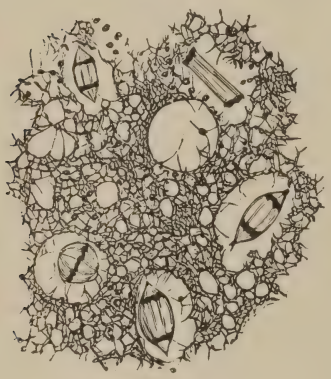


Fig. 4.—*Badhamia utricularis* Berk.

Division of nuclei by karyokinesis in the streaming plasmodium.

From a preparation stained in safranin, and mounted in Canada balsam, made by J. J. Lister.

Magnified 1,200 times.

Fig. 4.

in number, keeping pace with its growth by repeated division. This division has been observed repeatedly to take place by karyokinesis both in very young plasmodia, when one out of several nuclei may divide while the others remain in a resting stage, and also in large plasmodia where a wave of division has been seen to pass over a considerable area, affecting many hundreds of nuclei simultaneously (21) (fig. 4).*

Jahn first drew attention to the fact that in this division the nuclei of the plasmodium are seen to contain twice as many chromosomes as those counted in the dividing nuclei of the amoebulae ; thus proving that in the process of conjugation

* It must be admitted that the records of such mitotic divisions of nuclei in preparations of plasmodium are surprisingly few, considering the many attempts that have been made to observe the process ; and it appears possible that the nuclei may increase also by direct division, a suggestion supported by the following experiment. A rapidly growing plasmodium of *Badhamia utricularis*, feeding on the fungus *Auricularia*, spread over it, increasing in size nearly fourfold in fourteen hours. During this time a small portion of the plasmodium was removed every quarter of an hour, smeared on a coverslip and stained. Each of the fifty-two stainings shows nuclei in the usual vast abundance and in none of them is there any appearance of karyokinetic division. That process occupies from one to one and a half hours in the division of nuclei which occurs

the haploid nuclei of the amoebulae united to form the diploid nucleus of the zygote, of which these nuclei in the plasmodium are the descendants (16, p. 244). In the genera *Badhamia*, *Physarum*, *Trichia*, and *Arcyria* sixteen chromosomes have been counted in the dividing nuclei of the plasmodium, and eight in those of the swarm-cells ; while Harper counted twelve chromosomes in the diploid nuclei of *Fuligo* (10).

The Sporangium.—The formation of the sporangium has been minutely described by de Bary (2, p. 424), and a brief notice of the general characters will be sufficient here. In many cases as long as the supply of food is sufficient so long will the plasmodium continue to feed and grow ; when the nourishment is exhausted it prepares to pass into the fruiting stage : but in other cases sporangia develop when the food supply appears to be still abundant, and the cause of the change is then obscure. Preparatory to sporangia being formed the plasmodium usually leaves the moist surroundings where it has been feeding and creeps to some drier place more suited to the dispersion of the spores. It concentrates at certain points and develops into sporangia of the forms characterstic of the species.

In examining the rising sporangia of *Physarum nutans* in a moist chamber under the microscope, the projecting masses of plasmodium are seen to pulsate, swelling or shrinking as the rhythmic flow advances or retreats, but gradually growing with the advancing movement. As the sporangia develop, an envelope, the *sporangium-wall*, is secreted by the protoplasm at the surface. It is at first of a gelatinous consistency, but ultimately becomes membranous. The basal walls of the young sporangium in this species usually form a stalk, a tube of tougher substance, through which the protoplasm continues to flow until the surrounding veins have emptied their contents into the spherical head ; the walls of the stalk then contract upon themselves and provide a firm support for the sporangium. The stalks of adjacent sporangia, or the sporangia themselves when sessile, are often connected at the base by a membrane or membranous strands secreted by the remains of the plasmodium ; this is termed the *hypothallus*. During the formation of the sporangia all waste matter which may have been ingested by the plasmodium is discharged, some of it being often deposited in the cavity of the stalk or within the hypothallus.

Soon after the formation of the sporangium-wall, a system

before spore-formation ; assuming that it occupies an equal time in the growing plasmodium, and that during those fourteen hours the nuclei had increased fourfold (an increase corresponding with the growth of the plasmodium), it is difficult to see how mitosis could have escaped detection if it had been widespread and affecting many nuclei simultaneously. The size of the nuclei varied from 2·5 to 5 μ, and occasionally there were appearances suggestive of direct division taking place, but these may possibly have been due to the overlapping of one nucleus on another (21).

of tubes, or slender tubular threads is usually developed within the sporangium forming the *capillitium*, a structure which eventually aids in the dispersion of the spores. It is secreted in vein-like vacuoles or invaginations traversing the protoplasm (3) (12).

In the *Stemonitaceae* the stalk and its upward continuation, the *columella*, are axial structures secreted in the interior of the young sporangium ; this at first consists of a short pillar of plasmodium within which the base of the stalk is secreted, in a vacuolar cavity, as a hollow tube ; as the tube grows in length it forms a support up which the protoplasm climbs and gradually builds up the sporangium. The capillitium threads are formed later in a system of vacuoles spreading outward from the columella and inwards from the surface of the sporangium (3).

In the group *Calcarineae*, the granules of carbonate of lime which abound in the plasmodium are incorporated in various parts of the sporangium, either in the sporangium-wall, in the tubes of the capillitium or in expansions of the capillitium-threads (*lime-knots*), in the stalk, or in all these parts. In the genus *Didymium* the lime-granules of the plasmodium are dissolved in the sporangium, and the salt is deposited on the outer side of the sporangium-wall in the form of stellate crystals. The capillitium often shows adaptations for spore dispersion of considerable complexity and great beauty. On the characters of the varied forms many of the generic and specific distinctions have been based ; they are fully described in the text.

The sporangia are either scattered or clustered ; or they unite to form an *aethalium*, a cushion-like structure consisting of numerous sporangia closely combined and having the sporangium-walls within the cushion more or less imperfectly developed ; common examples of such aethalia are seen in *Fuligo* and *Reticularia*. The simple forms are either stalked or sessile, or they may spread on the substratum with an irregular outline, when they are called *plasmodiocarps*.

Spore Formation.—The formation of spores is preceded by the division of the nuclei by karyokinesis, each daughter nucleus becoming the nucleus of a spore. The process of division was first recorded by Strasburger in the genus *Trichia* (32). Jahn has shown that this is a reduction division, by which the number of chromosomes is reduced to one half. Thus it comes about that the nuclei of the spores and of the swarm-cells formed from them on germination are haploid, that is they have half the full number of chromosomes. As stated above, this full number is restored later by the fusion of the haploid nuclei of pairs of amoebulae in the formation of the zygotes. A small proportion of the nuclei do not take part in spore-formation but degenerate, the number of such

degenerating nuclei being much increased if the sporangia are not healthy. Jahn observed fusions taking place among these nuclei, but concludes that this occurs only in unhealthy



Fig. 5.—*Comatricha nigra* Schroeter.

From a stained preparation of a young sporangium, showing the spore-plasm separated into rounded masses about groups of nuclei, which are dividing by karyokinesis; the nuclear division has reached the 'spindle stage'; the spindles are seen in profile in all cases but one in which the equatorial plate is seen from one of the poles of the spindle. Magnified 1,200 times.

Fig. 5.

sporangia and is a purely vegetative phenomenon which has nothing to do with a sexual process (16, p. 234).

In most Mycetozoa the division of nuclei within the sporangium is accompanied by a cleavage of the surrounding protoplasm into masses; these become subdivided until they are

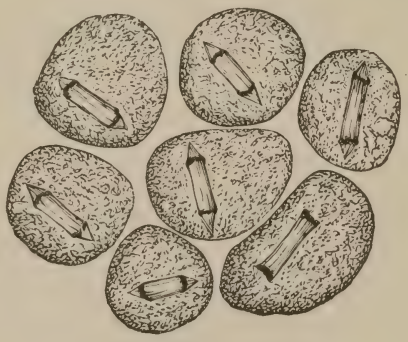


Fig. 6.—*Comatricha nigra* Schroeter.

From a stained preparation of a young sporangium, showing the plasma separated into masses of two spores' capacity round the nuclei, which have almost divided by karyokinesis. Magnified 1,200 times.

Fig. 6.

reduced to spheres of two spores, capacity containing a dividing nucleus (figs. 5, 6), by a final constriction they divide into spores each provided with one of the daughter nuclei. The process of cleavage is not quite simultaneous throughout the whole sporangium but begins at the periphery and passes inwards, the cleavage furrows often radiating from the lines of the

capillitium (3) (11). In *Lycogala*, *Trichia* and *Arcyria* cleavage does not take place till the daughter nuclei have separated, when the surrounding protoplasm divides directly to form the spores. A spore-wall is soon secreted, which is finally adorned with characteristic markings, consisting either of warts, spines, or ridges. The water contained in the spores is then expelled and they lie dry and loose awaiting dispersion by the breaking of the sporangium-wall, when the presence of a capillitium within the sporangium usually regulates and assists in their distribution.

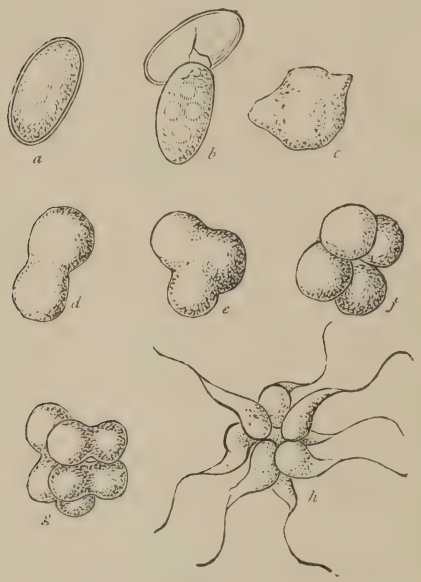


Fig. 7.—*Ceratiomyxa fruticulosa* Macbr.

a. Spore.

b. Spore-contents escaping from the spore-wall.

c to *g*. Successive stages in the division of the naked spore to eight.

h. Cluster of eight swarm-cells.

Magnified 1,200 times.

Fig. 7.

EXOSPOREAE.—The sporophores of *Ceratiomyxa*, the single representative of the *Exosporeae*, are fragile white branching or anastomosing structures appearing often in great abundance on decayed wood. The colourless ellipsoid spores are borne on slender stalks arising from the surface of the sporophore (plate 1, *d*). The ripe spores differ from those of the *Endosporeae* in containing four nuclei. On being moistened the membranous spore-wall is thrown off with a jerk from the swelling of the contents (fig. 7 *b*). The latter at first show slight amoeboid movements, putting out pointed pseudopodia, but soon the four nuclei divide by karyokinesis, and the whole cell separates successively into two, four, and eight parts; each of the eight uninucleate parts acquires a flagellum and

swims off as a pyriform swarm-cell (fig. 7, *c* to *h*). The swarm-cells have been observed to withdraw their flagella and become amoebulae ; although they have not been seen to conjugate in pairs before forming plasmodia it may be inferred that this takes place, since Dr. Jahn was able to count eight chromosomes in the nuclear division preceding the formation of the swarm-cells, and sixteen in those of the young sporophore before spore-formation, showing that when the latter stage is reached the haploid nuclei have become diploid. The plasmodium inhabits decaying wood and is invisible until it comes to the surface to produce sporophores. It then emerges in the form of cushions of transparent jelly. If such a cushion is placed on a glass slide and kept moist, the jelly is seen under the microscope to be traversed by a dense network of protoplasmic veins in which a rhythmic streaming of granules characteristic of the Mycetozoa can be watched. From the cushions, antler-like branches grow out, over the surface of which the protoplasm concentrates and forms an enveloping layer. It is at this stage that most of the nuclei undergo a reduction division, while the remainder contract and degenerate (fig. 8, *a* to *c*). It was suggested by Prof. Minchin that in this degeneration we see a process of elimination of effete or negative chromatin preceding the formation of the gametes or their nuclei (see 'An Introduction to Protozoology' 142, 1912).

The superficial network of protoplasm then becomes closer and thinner and divides up to form a mosaic of uninucleate cells which completely covers the upper part of the gelatinous sporophore and is more loosely distributed in the lower part. This 'mosaic stage', as it was called by Famintzin and Woronin in their classic work on *Ceratiomyxa* (7) soon passes into the spore-bearing stage, when each cell pushes outwards and grows into a stalked spore containing a single nucleus ; the latter soon divides twice by karyokinesis, and so the four nuclei of the mature spore are produced (24). The spores are readily detached from their stalks, and the gelatinous sporophores dry up to form frail structures to disappear with the first shower of rain.

Ceratiomyxa thus differs from the *Endosporeae* not only in the development of the spores from the surface of sporophores, but in the fact that the mature spore contains four nuclei ; and these on germination at once divide again as the parent cell separates into eight swarm-cells ; in the *Endosporeae* the increase to eight swarm-cells from one spore is arrived at slowly and only after repeated intervals of feeding.

Specific characters.—The different species of Mycetozoa are mainly distinguished by the form and colour of the sporangium and capillitium, and by the colour, size, and markings of the

spores; on the whole these characters are wonderfully constant from whatever part of the world the specimen may



Fig. 8. *Ceratiomyxa fruticulosa* Macbr.

a. Young sporophore. Magnified 40 times.

b. Strand from the network of protoplasm, showing resting nuclei.

c. Later stage showing four nuclei dividing by karyokinesis.

d. Later stage showing the network of protoplasm dividing into a fine thin surface net through which the daughter nuclei are distributed; three degenerate nuclei are seen.

e. Spore-mother-cells from the mosaic-stage. *b* to *e*.

Magnified 930 times, from preparations made by Dr. Jahn.

be obtained. Yet climate has apparently a marked effect on the sporangia of some species. Examples of the genus *Cribraria* from the United States and the tropics are usually

more elegant in form and regular in character than individuals of the same species from Britain, a result due possibly to the more favourable and equable climatic conditions under which they developed. In this country our moist and changeable weather may often have a disturbing effect on young sporangia. On old stumps which have been long under observation, growths of *Trichia affinis* may continue to present the same typical characters from one season to another. The capillitium in this genus consists of *elaters*, that is of free tubular threads marked with close-set spiral bands ; being sensitive to moisture the elaters twist and wave as currents of dry or damp air pass over them, and by their movements aid in scattering the light spores. Should cold weather set in while the plasmodium is rising to form sporangia, the capillitium will probably be abnormal, and the regular spirals are replaced by rugged irregular bands or ring-shaped thickenings. Normal developments of *Trichia persimilis* have been followed after a few nights' frost by a growth in which the short and nearly smooth elaters closely resemble those of *Oligonema nitens*, while the spores and the shape of the sporangia retain the normal character. But there are many cases where no cause can be assigned for the appearance of unusual characters. As an example two varieties of *Lamproderma atrosporum* may be referred to. These differ from each other so strikingly in habit in capillitium and spore-markings as to suggest at first that they are only distantly related. Yet they have been found year after year very closely associated in more than one locality ; moreover, they are sometimes accompanied by sporangia intermediate in character, showing that they must be regarded as variants of one species ; no clue has yet been found to account for the appearance of such diverging characters.

Distribution. Habitats.—The Mycetozoa are remarkably cosmopolitan in their distribution, occurring all over the world wherever there is sufficient decaying vegetation and moisture for their support. While some species have a very wide range, others are especially characteristic of temperate regions ; others again are found chiefly in the tropics, and a few species apparently occur only in alpine situations. The habitats they frequent are many and varied. The greater number of Mycetozoa feed within decaying wood, and their sporangia appear on old stumps, fallen branches and twigs, or on old sawdust heaps. Dead coniferous wood is the habitat for most species of *Cribraria*. In the tropics, palm-trunks clothed with persistent fibrous bases of the leaves provide a suitable feeding ground for many plasmodia. Heaps of decaying leaves, old straw, or straw-manure may be prolific in species of *Physarum*, *Craterium*, *Didymium*, &c. In

alpine regions, turf and dead herbaceous stems, exposed in spring by thawing of the snows under which they have lain hidden for many months, often abound with characteristic species of *Lepidoderma* or *Lamproderma*, whose plasmodia have developed under the snow. On *Sphagnum*-bogs appear *Badhamia lilacina* and *Lepidoderma tigrinum*, while other species have been found on open moorland and bare soil; in such exposed situations the sporangia are soon washed away by rain and may be easily overlooked. Living pilei of leathery fungi form the habitat of a few species. *Badhamia utricularis* feeds on species of *Stereum*, *Physarum rigidum* on *Schizophyllum*, while *Trichamphora* has been found repeatedly on *Auricularia* as well as on decaying leaves.*

About three hundred species of Mycetozoa are recognized at the present time, thirty of which have been added since the last edition of this work appeared. A hundred and ninety species have been recorded from Great Britain and Ireland.

Note for Collecting.—In collecting Mycetozoa it is well to be provided with small boxes lined with cork to which fragile specimens may be securely pinned. Immature sporangia should be kept in a moist atmosphere until they have reached maturity. When this stage is attained they should be kept as dry as possible and guarded from the attacks of insects; they may then be preserved for an indefinite length of time. In this country all that is needful is to fasten them by glue to the trays of store-boxes, or, better, to pasteboard trays fitting into store-boxes, and keep them in a dry cabinet with an abundant supply of naphthaline. In the moist climate of the tropics it has been found useful to expose the specimens to sunlight to dry them thoroughly, and afterwards to subject them to strong fumes of benzene to destroy insects, before placing them in store-boxes. It may be noted, however, that, should no better means of transport be at hand, many specimens will arrive in an identifiable condition after having been sent by post merely folded in a wrapping of soft paper enclosed in an envelope.

Owing to the perfection in which the dried sporangia retain their characters, when carefully preserved, we possess in the different herbaria representative collections of specimens from many parts of the world, some of them dating back to over a hundred years, which may be as easily identified as when first gathered.

Mounting.—For making permanent mountings glycerine jelly is the best medium for most species, as it does not cause shrinking of the spores, whose size and markings are often characteristic; unfortunately the calcareous granules em-

* For a more detailed account of the haunts of the Mycetozoa see G. Lister, 'Mycetozoa', Essex Field Club Special Memoir, No. vi, 13–32 (1918).

bedded in the sporangium-wall and in the 'lime-knots' of the capillitium in the *Calcarineae* are sooner or later dissolved in the jelly, as they are in most mounting media. In three genera—*Cribraria*, *Dictydium*, *Lindbladia*—a characteristic feature is the presence of minute 'plasmodic granules' embedded in the sporangium-walls, which vary in size and colour in the different species; these granules dissolve in jelly but are well preserved in Canada balsam.

Although much has been discovered in recent years as to the life-history and distribution of the Mycetozoa, many problems remain to be solved, both in the field and in the laboratory, especially as regards the relation of the species to their environment and to one another.

In the following pages the contractions K. and B.M. are used to indicate specimens in the collections at Kew and in the British Museum. The measurements of spores in the descriptions of species are expressed in terms of thousandths of a millimetre, symbolized by the Greek letter μ. The colour of the spores is given as they appear when magnified 600 diameters, and the markings of the spore-wall as seen when magnified 900 times.

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SYNOPSIS OF FAMILIES AND LIST OF GENERA OF MYCETOZOA

Subclass I.—EXOSPOREAE.

Spores developed outside a sporophore. (P. 4)

Family I.—Ceratiomyxaceae. Sporophores membranous, branched ; spores white, borne singly on filiform stalks arising from the areolated sporophore. (P. 4)

Genus 1. *Ceratiomyxa* Schroeter. (P. 4)

Subclass II.—ENDOSPOREAE.

Spores developed inside a sporangium. (P. 5)

Order I.—*AMAUROSPORALES*. Spores violet-brown * or purplish-grey (ferruginous in *Stemonitis ferruginea* and *S. flavogenita*, colourless in *Echinostelium*). (P. 5)

Suborder I.—*CALCARINEAE*. Sporangia provided with lime (calcium carbonate). (P. 5)

Family I.—Physaraceae. Lime in the form of minute round granules (sometimes in rounded nodules or absent in *Diachea*). (P. 5)

Genus 2. *Badhamia* Berk. (P. 9)
3. *Physarum* Pers. (P. 20)
4. *Fuligo* Haller (P. 66)
5. *Erionema* Penzig (P. 70)
6. *Trichamphora* Jungh. (P. 71)
7. *Physarella* Peck (P. 72)
8. *Cienkowskia* Rost. (P. 73)
9. *Craterium* Trentep. (P. 74)
10. *Leocarpus* Link (P. 80)
11. *Diderma* Pers. (P. 81)
12. *Physarina* von Höhnel (P. 100)
13. *Diachea* Fries (P. 101)

Family II.—Didymiaceae. Lime in crystals deposited outside the sporangium-wall (scanty or none in *Leptoderma*). (P. 106)

Genus 14. *Didymium* Schrad. (P. 108)
15. *Mucilago* Adanson (P. 123)
16. *Lepidoderma* de Bary (P. 124)
17. *Leptoderma* G. Lister (P. 127)

* The colours of the spores are given throughout as they are seen when magnified and with transmitted light.

Suborder II.—*AMAUROCHAETINEAE*. Sporangia without lime. (P. 128)

Family I.—Collodermaceae. Sporangium distinct, sessile, with an outer gelatinous wall. (P. 128)

Genus 18. *Colloderma* G. Lister. (P. 128)

Family II.—Stemonitaceae. Sporangia distinct, provided usually with a stalk and columella. (P. 129)

Genus 19. *Stemonitis* Gled. (P. 131)
20. *Comatricha* Preuss (P. 139)
21. *Enerthenema* Bowm. (P. 149)
22. *Lamproderma* Rost. (P. 151)
23. *Clastoderma* Blytt (P. 161)
24. *Echinostelium* de Bary (P. 162)
25. *Barbeyella* Meylan (P. 162)

Family III.—Amaurochaetaceae. Sporangia combined to form an aethalium. (P. 163)

Genus 26. *Amaurochaete* Rost. (P. 164)
27. *Brefeldia* Rost. (P. 165)

Order II.—*LAMPROSPORALES*. Spores variously coloured, not violet-brown or purplish-grey (except in *Licea minima* and *Listerella*, q.v.). (P. 166)

Suborder I.—*ANEMINEAE*. Capillitium wanting, or if present not forming a system of uniform threads (except in *Alwisia*, q.v.). (P. 166)

Family I.—Heterodermaceae. Sporangium-wall membranous, beset with microscopic round plasmodic granules, and (except in *Lindbladia*) forming a net in the upper part. (P. 166)

Genus 28. *Lindbladia* Fries (P. 167)
29. *Cribraria* Pers. (P. 168)
30. *Dictydium* Schrad. (P. 178)

Family II.—Liceaceae. Sporangia solitary ; sporangium-wall cartilaginous or membranous. (P. 180)

Genus 31. *Licea* Schrad. (P. 181)
32. *Hymenobolina* Zukal (P. 185)
33. *Orcadella* Wing. (P. 185)

Family III.—Tubulinaceae. Sporangium-wall membranous, without plasmodic granules ; sporangia clustered, cylindrical or ellipsoid. (P. 186)

Genus 34. *Tubifera* Gmelin (P. 187)
35. *Alwisia* Berk. & Br. (P. 189)

Family IV.—Reticulariaceae. Sporangia closely compacted and usually forming an aethalium ; sporangium-walls incomplete or forming a spurious capillitium ; true capillitium none, or in *Liceopsis* consisting of a few branching threads or strands. (P. 190)

Genus 36. *Dictydiaethalium* Rost. (P. 191)
37. *Enteridium* Ehrenb. (P. 193)
38. *Reticularia* Bull. (P. 195)
39. *Liceopsis* Torrend (P. 196)

Family V.—Lycogalaceae. Sporangia forming an aethalium ; pseudo-capillitium consisting of branched colourless tubes. (P. 197)

Genus 40. *Lycogala* Adanson (P. 197)

Suborder II.—*CALONEMINEAE*. Capillitium present as a system of uniform or sculptured threads. (P. 201)

Family I.—Trichiaceae. Capillitium consisting of tubular threads, which are either free and usually unbranched ('elaters') or form a network branching at wide angles, with thickenings in the form of spirals or rings. (P. 201)

Genus 41. *Trichia* Haller (P. 202)
42. *Oligonema* Rost. (P. 215)
43. *Calonema* Morgan (P. 217)
44. *Hemitrichia* Rost. (P. 217)
45. *Cornuvia* Rost. (P. 226)

Family II.—Arcyriaceae. Capillitium a network of tubular threads branching at wide angles, smooth or thickened with cogs, half rings (rings in *Arcyria annulifera*), spines, or warts (capillitium often scanty and of free threads in *Perichaena corticalis* and *P. quadrata*). (P. 227)

Genus 46. *Arcyria* Wiggers (P. 228)
47. *Lachnobolus* Fries (P. 241)
48. *Perichaena* Fries (P. 242)
49. *Minakatella* G. Lister (P. 250)

Family III.—Margaritaceae. Capillitium consisting of solid threads, either coiled and hair-like or nearly straight and attached to the sporangium-wall, simple or branching at acute angles. (P. 250)

Genus 50. *Margarita* Lister (P. 252)
51. *Dianema* Rex (P. 253)
52. *Prototrichia* Rost. (P. 256)
53. *Listerella* Jahn (P. 257)

MYCETOZOA de Bary.

Subclass I.—EXOSPOREAE.

Spores developed outside sporophores.

Family I.—Ceratiomyxaceae.

Sporophores membranous, branched ; spores white, borne singly on filiform stalks rising from the areolated sporophore.

Genus 1.—**CERATIOMYXA** Schroeter in Engler & Prantl Nat. Pflanzenfam., I. i. 16 (1889) (κέρας antler, μύξα slime). Sporophores consisting of flattened membranous tubes, either branching from a common base or forking repeatedly or forming a network ; the surface is mapped out into polyhedral areolae, from the centre of each of which arises a slender stalk bearing a single ellipsoid colourless spore.—*Ceratium* Alb. & Schw. Consp. Fung., 358 (1805) *non* Schrank (1793).

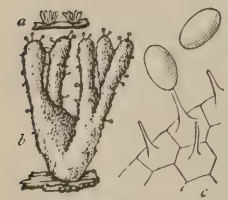


Fig. 9.

Fig. 9.—*Ceratiomyxa fruticulosa* Macbr.

a. Clusters of sporophores. Twice natural size.

b. Sporophore. Magnified 40 times.

c. Four areolae of mature sporophore; one spore still attached to its stalk, and another free. Magnified 480 times.

1. **C. fruticulosa** Macbr. N. Am. Slime-Moulds, 18 (1899) (*fruticulus* small bush). Plasmodium colourless. Sporophores white or pinkish-yellow, rarely sulphur or apricot coloured, forming a tuft of simple or forked fasciculate branches 1 mm. or more high, 0·07 mm. thick, or consisting of more or less anastomosing broad bands, from which arise irregular lobes. Spores white, smooth, ovoid, 10 × 6 to 13 × 7 μ.—*Byssus fruticulosus* Muell. in Fl. Dan., 6, t. 718, fig. 2 (1777). *Tremella hydnoidea* Jacq. Misc., i. 145, t. 16 (1778). *Clavaria puccinea* Batsch Elench. Fung., 139, fig. 49 (1783). *C. byssoides* Bull. Champ. 209, t. 415, fig. 2 (1791). *Puccinia byssoides* Gmel. Syst. Nat., 1462 (1791). *Isaria mucida* Pers. in Roemer, N. Mag. Bot. i. 121 (1794). *Ceratium hydnoides* Alb. & Schw. Consp. Fung., 358 (1805) ; Fr. Syst. Myc. iii. 294 ; Fam. & Wor. in Mém. Acad. Imp. Petersb., sér. 7, xx. 4 (1873) ; Zopf Pilzthiere, 69 & 174 ; de Bary Comp. Morph. Fungi, 432 ; Cooke Brit. Fungi, ii. 550. *C. pyxidatum* Alb. & Schw. l.c. 359. *Ceratiomyxa mucida* Schrcet. in Engl. & Prantl Nat. Pflanz., I. i. 16 (1889) ; Lister Mycetozoa, 25 (1894).

Var. 1.—**flexuosa** Lister l.c. 26 (1894). Sporophores long, slender, white, profusely branching but not anastomosing, 2 to

5 mm. high.—*Ceratium arbuscula* Berk. & Br. in Journ. Linn. Soc., xiv. 97 (1873). *C. filiforme* Berk. & Br. l.c.

Var. 2.—**porioides** Lister l.c. (*Poria* a genus of fungi). Sporophores densely compacted to form a honeycomb-like growth, superficially resembling *Polyporus vulgaris* Fr., though more minute.—*Ceratium porioides* Alb. & Schw. l.c. *C. crustosum* Berk. & Curt. in Grev. iii. 62 (1874). *Ceratiomyxa porioides* Schroet. l.c.; Macbr. l.c. ed. 2, 20.

Var. 3.—**caesia** G. Lister (*caesius* bluish-grey). Resembling var. *porioides*, but tinged with blue, and developing from blue-green plasmodium.—*Ceratiomyxa caesia* Jahn in Ber. Deutsch. Bot. Ges., xxxvi. 660 (1918).

Pl. 1. *a*. Sporophores of typical form (England); *b*. sporophores of var. *flexuosa* (Ceylon); *c*. sporophores of var. *porioides* (Iowa); *d*. clavate end of sporophore; all the spores but five have fallen from their stalks; *e*. spore.

Intermediate forms connecting var. *flexuosa* and var. *porioides* with typical *C. fruticulosa* are of frequent occurrence; var. *caesia* was found in June 1916, in the province of Brandenburg.

Habitat. On rotten wood; common and widely distributed, appearing in Britain in summer: var. *flexuosa* abundant in the tropics, recorded also from Japan and South Africa: var. *porioides* is less common; Europe, South Africa, Japan, United States; not yet recorded from Britain.

Subclass II.—ENDOSPOREAE.

Spores developed within sporangia.

Order I.—*AMAUROSPORALES*.

Capillitium present. Spores violet-brown or purplish-grey (ferruginous in *Stemonitis ferruginea* and *S. flavogenita*, colourless in *Echinostelium*).

Suborder I.—*CALCARINEAE*.

Deposits of lime either (*a*) in minute granules included in the sporangium-wall, in expansions of the capillitium or in the stalk; or (*b*) in the form of stellate or lenticular crystals scattered over the sporangium-wall.

Family I.—Physaraceae.

Deposits of lime in minute round granules more or less aggregated, included in the sporangium-wall and in vesicular expansions of the capillitium (lime-knots), except in *Diderma* and *Physarina* where there are no lime-knots, and in *Diachea*, in which the lime is confined to the stalk and columella and is sometimes in the form of rounded nodules. In this family, and also in Fam. 2, *Didymiaceae*, the stalk of the sporangium is developed as an open tube, through which protoplasm passes to form the young swelling sporangium; later, the walls of the stalk contract in folds, often enclosing refuse matter (a probable exception in *Physarum penetrale*).

KEY TO THE GENERA OF *PHYSARACEAE*.

A. Capillitium a coarse network charged with lime throughout. (2) BADHAMIA



Fig. 10.

Fig. 10.—*Badhamia utricularis* Berk.

a. Cluster of sporangia. Magnified 3½ times.

b. Fragment of capillitium and spore-cluster. Magnified 140 times.

B. Capillitium a network of slender threads with vesicular expansions filled with lime-granules (lime-knots).

a. Sporangia combined into a convolute aethalium. (4) FULIGO



Fig. 11.

Fig. 11.—*Fuligo septica* Gmel.

a. Aethalium. One-third natural size.

b. Capillitium threads with lime-knots and two spores. Magnified 120 times.

b. Sporangia single, scattered or aggregated.

Sporangia subglobose, lenticular, or in the form of plasmodiocarps; capillitium without free hooked branches. (3) PHYSARUM



Fig. 12.

Fig. 12.—*Physarum nutans* Pers.

a. Two sporangia. Magnified 9 times.

b. Capillitium threads, with lime-knots, attached to a fragment of the sporangium-wall. Magnified 110 times.

Sporangia long, cylindrical, branching; capillitium a close elastic network, with minute lime-knots. (5) ERIONEMA

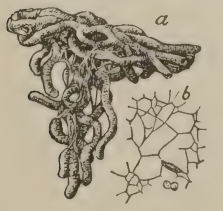


Fig. 13.

Fig. 13.—*Erionema aureum* Penzig.

a. Cluster of sporangia. Magnified 6 times.

b. Capillitium and spores. Magnified 140 times.

Sporangia saucer-shaped on dark reddish stalks.

(6) TRICHAMPHORA



Fig. 14. *Trichamphora pezizoidea* Jungh.

a. Group of sporangia. Magnified 5½ times.

b. Capillitium with two spores. Magnified 140 times.

Fig. 14.

Sporangia shortly cylindrical, tubular, stalked.

(7) PHYSARELLA



Fig. 15.—*Physarella oblonga* Morg.

Two sporangia, one perfect, the other dehiscing in revolute lobes from the funnel-shaped columella. Magnified 6½ times.

Fig. 15.

Plasmodiocarps cylindrical, branching and anastomosing; capillitium with free hooked branches; lime-knots taking the form of vertical plates.

(8) CIENKOWSKIA

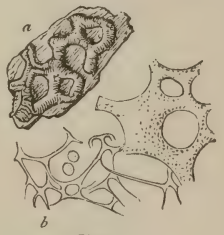


Fig. 16.—*Cienkowskia reticulata* Rost.

a. Part of branching plasmodiocarp. Magnified 4 times.

b. Capillitium threads and part of a perforated lime-plate. Magnified 140 times.

Fig. 16.

Sporangia in the shape of a covered goblet, ovoid; stalks cartilaginous.

(9) CRATERIUM



Fig. 17.—*Craterium minutum* Fr.

a. Two sporangia; in one the lid has fallen away. Magnified 10 times.

b. Capillitium with lime-knots and two spores. Magnified 110 times.

Fig. 17.

Sporangia ovoid, shining, clustered ; stalks membranous.
(10) LEOCARPUS

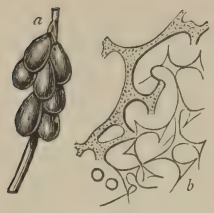


Fig. 18.

Fig. 18.—*Leocarpus fragilis* Rost.

a. Cluster of sporangia. Magnified 2½ times.

b. Hyaline threads and a branching lime-knot of the capillitium, with two spores. Magnified 120 times.

C. Capillitium without lime-knots.
Sporangium-wall opaque, smooth. (11) DIDERMA

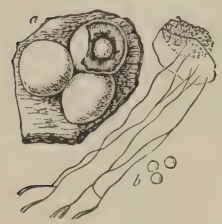


Fig. 19.

Fig. 19.—*Diderma testaceum* Pers.

a. Group of three sporangia ; in the upper one the double wall is broken away in part and the columella exposed. Magnified 9 times.

b. Portion of the outer and inner layers of the sporangium wall, to the latter the capillitium threads are attached; three spores. Magnified 170 times.

Sporangium-wall opaque, rough with numerous blunt peg-like prominences.
(12) PHYSARINA

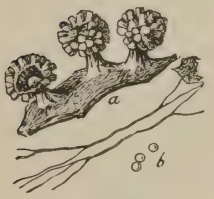


Fig. 20.

Fig. 20.—*Physarina echinocephala* von Höhnel.

a. Sporangia. Magnified 15 times.

b. Capillitium and spores with fragment of sporangium-wall. Magnified 140 times.

Sporangium-wall hyaline, without lime.
(13) DIACHEA



Fig. 21.

Fig. 21.—*Diachea leucopoda* Rost.

Two sporangia, one entire, the other deprived of the spores and showing capillitium and columella. Magnified 22 times.

Genus 2.—**BADHAMIA** Berkeley in Trans. Linn. Soc., xxi. 153 (1852). (Rev. C. D. Badham, M.D., 1806 to 1857, a writer on fungi.) Sporangia stalked, sessile, or forming plasmodiocarps; sporangium-wall single, with included lime-granules; capillitium consisting of a coarse network charged with granules of lime (sometimes constricted here and there into narrow hyaline threads); spores clustered or free, warted, reticulated, or nearly smooth.

KEY TO THE SPECIES OF *BADHAMIA*.

A. Spores clustered :—

a. Spores warted chiefly on one side—

α. Sporangia 1 to 1·5 mm. diam.—

* Lime in sporangia and capillitium white—

Plasmodium yellow; sporangia grey, clustered or scattered, sessile or with membranous stalks. 1. *B. capsulifera*

Sporangia grey, with firm stalks. 2. *B. papaveracea*

Plasmodium white; sporangia white, heaped. 3. *B. populina*

** Lime in sporangia and capillitium yellow. 8. *B. nitens*

β. Sporangia 0·3 to 0·5 mm. diam.; capillitium white or apricot-coloured. 9. *B. versicolor*

b. Spores equally warted all over. 4. *B. utricularis*

B. Spores not clustered :—

a. Sporangia yellow or orange—

Sporangia sessile. 10. *B. decipiens*

Sporangia stalked. 17. *B. viridescens*

b. Sporangia white or grey—

Sporangia globose, sessile or on short membranous stalks; spores violet-brown; plasmodium orange. 5. *B. foliicola*

Sporangia globose, sessile; spores pale lavender-grey, nearly smooth; plasmodium yellowish-white. 6. *B. alpina*

Sporangia globose on long membranous stalks; spores nearly smooth, blackish. 7. *B. magna*

Sporangia subglobose, sessile or with firm yellow or brown stalks; spores closely spinulose, dark purple-brown. 11. *B. macrocarpa*

Sporangia subglobose or discoid, sessile or stalked; stalks black, or black below, grey above; spores violet-brown. 12. *B. affinis*

Sporangia subglobose, sessile, clustered; spores violet-brown, nearly smooth; plasmodium white. 13. *B. panicea*

c. Sporangia chalk-white, sessile, hemispherical or forming plasmodiocarps; spores smooth, ellipsoid. 14. *B. ovispora*

d. Sporangia flesh-coloured or purple-brown—

Sporangia sessile, without a true columella. 15. *B. lilacina*

Sporangia stalked, stalk continued into the sporangium as a columella. 16. *B. rubiginosa*

1. **B. capsulifera** Berk. in Trans. Linn. Soc., xxi. 153 (1852) (*capsula* a little case, *fero* I bear). Plasmodium chrome-yellow. Sporangia more or less clustered, globose or pyriform, usually sessile, 1 to 1·5 mm. diam., greyish-white; sporangium-wall hyaline, with lime-granules sparsely distributed. Stalk when present membranous, straw-coloured, short. Capillitium a network of flat bands with broad thin expansions at the angles; lime-granules evenly but not densely distributed throughout. Spores dark purple-brown, adhering in clusters of 8 to 20, spinulose, more strongly warted on the outer surface as they lie in the cluster, 11 to 13 μ diam.—Rost. Mon., 141. Macbr. N. Am. Slime-Moulds, ed. 2, 40. *Sphaerocarpus capsulifer* Bull. Champ. 139, t. 470, fig. 2 (1791). *Physarum hyalinum* Pers. in Roemer, N. Mag. Bot., i. 88 (1794)? *P. cinereum* Link in Berl. Mag., iii. 27 (1809)? *P. capsuliferum* Chev. Fl. Par., 339 (1826). *P. cancellatum* Wallr. Fl. Crypt. Germ., 351 (1833)? *P. botryoides* var. *hyalinum* Fr. Stirp. Femsj. 83 (1827). *Trichia capsulifer* DC. Fl. Fr., ii. 254 (1805). *Badhamia hyalina* Berk. l.c.; Rost. Mon., 139; Lister Mycetozoa, 30. *B. varia* Mass. Mon., 319 (1892) in part.

Var. **repens** G. Lister in Essex Nat., xviii. 319 (1918) (creeping). Sporangia scattered, forming slender curved plasmodiocarps.

Var. **arborea** G. Lister (arboreal, from the sporangia appearing on living trees). Sporangia scattered, 0·3 to 0·5 mm. diam.; spores pale purplish-grey, 13 to 16 μ diam., globose or oval.

Pl. 3. *a.* sporangia; *b.* fragment of capillitium with a cluster of spores and one free spore; *c.* spore (England).

This species usually forms small plasmodia. It is subject to considerable variation in the shape of the sporangia, and the clustering and markings of the spores. In some gatherings the spores are greyer and not so dark as

in the type, loosely adhering, and scarcely rougher on one side, not exceeding 10 to 11 μ diam. All intermediate forms occur between this and the typical form with its large and rather compact clusters of darker larger spores. *B. hyalina* Berk. is described as differing from *B. capsulifera* in having spherical instead of obovate sporangia, but as we not infrequently meet with both spherical and pyriform sporangia intermixed the shape cannot be accepted as distinctive. *B. capsulifera* is adopted as being the older specific name. Possibly *B. melanospora* Speg. (in Anal. Soc. Cient. Arg., x, p. 150 (1880)) with sessile sporangia and black spores clustered or free measuring 15μ, is a form of *B. capsulifera*, but in the absence of the type this must remain uncertain. Prof. Macbride describes a form of *B. capsulifera*, occurring in the State of Iowa, having white aggregate, superimposed sporangia, approaching *B. populina* in some respects (N. Am. Slime-Moulds, ed. 2, 41 (1922)).

The var. *arborea* has been obtained repeatedly in Aberdeenshire by the Rev. W. Cran among moss and lichen on trunks of living trees, associated with *B. versicolor* and *B. affinis* ; the fragile upper part of the sporangium-wall readily breaks away, leaving the flat base, which is thickened with refuse matter, adhering to the substratum : it is an inconspicuous but well marked form. The var. *repens* has been found by Mr. K. Minakata in Japan, also on living trunks ; possibly it is only a plasmodiocarp form of var. *arborea*, but it has rather darker spores.

Hab. On bark of fir, oak, alder, &c., not unfrequent in England and Scotland and widely distributed throughout Europe ; it has also been recorded from New South Wales and the State of Iowa.

2. **B. papaveracea** Berk. & Rav. in Grev., ii. 66 (1873) (*papaver* poppy). Plasmodium ? Sporangia subglobose, greyish-white, nearly smooth, 0·7 to 1 mm. diam., shortly stalked or sessile, gregarious ; sporangium-wall with scanty deposits of lime. Stalk firm, dark brown, rarely straw-coloured, 0·2 to 0·3 mm. high. Capillitium as in *B. capsulifera*. Spores purple-brown, closely compacted in clusters of 6 to 10, more strongly warted on the outer third, 10 to 13 μ diam.— Rost. Mon., App. 3 ; Mass. Mon., 323 (in part) ; Macbr. N. Am. Slime-Moulds, ed. 2, 42. *B. hyalina* var. *papaveracea* Lister Mycetozoa, 30 (1894).

Pl. 3. *d.* sporangia ; *e.* two clusters of spores (New Jersey).

This species is closely allied to *B. capsulifera* and connected with it by intermediate forms ; it is distinguished by the firmer stalks and the smaller more compact spore-clusters.

Hab. On dead bark ; recorded from the eastern States of North America, from New England to South Carolina and Iowa, and also from Japan.

3. **B. populina** Lister in Journ. Bot., xlii. 129 (1904) (*populus* poplar). Plasmodium white or cream-white. Sporangia white, rarely pale rose-coloured, subglobose or ovoid, smooth, 1·5 mm. diam., sessile, heaped, or rarely solitary on short yellowish-brown membranous stalks ; sporangium-wall with abundant deposits of lime-granules. Capillitium a coarse network of broad strands charged with lime-granules, sometimes with a few hyaline connecting threads. Spores 10 to 12 μ diam., in clusters of 16 to 20 or

more, purple-brown, minutely warted, the warting rather stronger on one side ; they are usually marked by one or more narrow ridges or bands.—Sturgis in Colorado Coll. Publ., Science Ser., xii. i. 11. Macbr. N. Am. Slime-Moulds, ed. 2, 41.

Pl. 2. *a*. sporangia ; *b*. fragment of capillitium with two clusters of spores and two free spores ; *c*. spores (England).

This species is allied to *B. capsulifera*, but is distinguished by the heaped white sporangia arising from white plasmodium, and by the spores being usually banded. Amongst numerous gatherings made by Dr. Sturgis and Mr. E. Bethel in Colorado, some sporangia have the dark banded spores characteristic of the English and French specimens, while others have paler spores with little or no banding ; these pale-spored forms approach very closely the paler-spored gatherings of *B. capsulifera*, typical examples of which appear to be seldom met with in North America.

Hab. On fallen logs of *Populus*, *Negundo*, &c. ; Essex, Yorks, France, Moldavia, Colorado.

4. **B. utricularis** Berk. in Trans. Linn. Soc., xxi. 153 (1852) (*utriculus* a little bag). Plasmodium chrome-yellow. Sporangia ovoid subglobose, free, or confluent and lobed, 0·5 to 1 mm. diam., usually clustered, cinereous, or iridescent-violet, usually veined with white, sessile or on clustered often long membranous straw-coloured branching stalks ; sporangium-wall hyaline with sparsely distributed minute granules of lime. Capillitium as in *B. capsulifera*. Spores bright brown or violet-brown, adhering in loose clusters of 7 to 10, spinulose, 9 to 12 μ diam.—Rost. Mon., 142, figs. 110–112 ; Macbr. N. Am. Slime-Moulds, ed. 2, 39. *Sphaerocarpus utricularis* Bull. Champ., ii. 128 (1791). *Trichia coerulea* Trentep. in Roth Catal. Bot., i. 229 (1797) ? *T. utricularis* DC. Fl. Fr., ii. 251 (1805). *T. rubiformis* Purt., in Brit. Pl. of Midl. Count., iii. 291, t. 37 (1821) *non* Pers. *Physarum ovoideum* Schum. Enum. Pl. Saell., ii. 198 (1803). *P. hyalinum β. chalybaeum* Alb. & Schw. Consp. Fung., 92 (1805). *P. botryoides* Fr. Stirp. Femsj., 83 (1825). *P. botrytes* Somm. Fl. Lapp., 242 (1826). *Diderma papaverinum* Wallr. Fl. Crypt. Germ., 375 (1833). *Badhamia varia* Mass. Mon., 319 (1892) in part.

Pl. 4. *a*. cluster of sporangia ; *b*. fragment of capillitium with a cluster of spores and three free spores ; *c*. cluster of spores ; *d*. spore (England).

This species differs from *B. capsulifera* in habitat, in having large plasmodia commonly producing some thousands of sporangia, and in the spores being brighter in colour and uniformly spinulose. In cultivations carried on continuously for many years, the four varieties described in Rostafinski's Monograph have presented themselves. The capillitium varied both in form and in the amount of lime it contained ; in some the threads were broad with wide expansions at the angles, in others they were narrow and but little widened at the angles ; in some the lime was abundant, in others only a few scattered granules could be found. The degree of clustering of the spores varied in different growths though all were cultivated from one original gathering of plasmodium, but they were never free. In some

specimens in the Strasburg collection the spores show but slight indication of clustering, in others this character is well marked. Sporangia developed under abnormal conditions sometimes form into dark flattened netlike plasmodiocarps, almost free from deposits of lime.

Hab. Plasmodium extensively creeping over the bark of fallen trees, logs, &c., feeding on living leathery fungi, especially *Stereum hirsutum* and *Polyporus versicolor*. Abundant in England, especially in autumn and winter; apparently less common in other parts of the British Isles; generally distributed throughout Europe and the United States, occurring also in Canada, South Africa, Queensland and New South Wales.

5. **B. foliicola** Lister in Journ. Bot., xxxv. 209 (1897) (*folium* leaf, *colo* I inhabit). Plasmodium orange. Sporangia subglobose, 0·5 to 1 mm. diam., iridescent-grey, sessile and crowded, or standing singly on slender pale yellowish-brown stalks 0·2 to 0·5 mm. long. Capillitium a network of slender strands with white lime-deposits. Spores free, sometimes showing a slight tendency to adhere in loose clusters, violet-brown, minutely spinulose, 8 to 11 μ diam.—Torrend Flore des Myxomycètes, 210 (1909); Macbr. N. Am. Slime-Moulds, ed. 2, 39.

Pl. 11. *a*. sporangia; *b*. capillitium and spores; *c*. spore (England)

This species is not infrequent in this country, where it sometimes occurs in great profusion on turf, on heaps of old straw or dead leaves, or on twigs. From *B. utricularis*, to which it is very closely allied, it is distinguished by the short stalks, the free and minutely spinulose spores, and by the difference of habitat; from *B. panicea* it differs in having orange plasmodium and rather rougher spores. The description of *B. microcarpa* Schroet. (in Cohn Krypt. Fl. Schlesien, iii, pt. i. 131, 1889) would apply to *B. foliicola* except that the spores are given as measuring only 7·5 to 9 μ; in the absence of the type, however, we cannot be sure that this reference is correct.

Hab. On turf, straw, dead leaves and twigs.—England, Scotland, Ulster, France, Germany, Switzerland, Roumania, Portugal, South Australia.

6. **B. alpina** G. Lister in Journ. Bot., lii. 99 (1914). Plasmodium yellowish-white or pale yellow. Sporangia scattered or clustered, sessile, subglobose or hemispherical on a broad base, 0·5 to 0·9 mm. diam., grey or iridescent, usually seated on a dark hypothallus. Capillitium a close network of slender tubes enclosing scanty deposits of lime. Spores free, greyish lilac, almost smooth or very minutely warted, 10 to 12 μ diam.

This alpine species differs from *B. foliicola*, which it closely resembles, in the pale colour of the plasmodium, the more hemispherical sporangia, and the paler smoother spores.

Hab. On dead twigs, on and within the old hollow scapes of *Cirsium*, *Veratrum*, &c.; apparently not uncommon on the Swiss alps; also found on high ground in Jämtland, Sweden.

7. **B. magna** Peck in Rep. New York Mus., xxxi. 57 (1879) (large). Plasmodium ? Sporangia globose, 1 mm. diam., violet-grey, iridescent, clustered on long membranous yellowish

slender branching stalks 4 mm. long or more ; sporangium-wall with scanty deposits of lime. Capillitium as in *B. capsulifera* Berk. Spores purplish-black, very minutely spinulose, with a paler smoother area of dehiscence, not clustered, 9 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 38. *Dictydium magnum* Peck l.c., xxiv. 84 (1872). *B. varia* Mass. Mon., 319 (1892) (in part).

Pl. 9. *a*. sporangia (Vermont, N. York ; Peck's type) ; *b*. spores.

The typical forms of this species with very dark, almost smooth and free spores appears to have been recorded only from the United States ; specimens having rather rougher and slightly clustered spores occur and merge into *B. utricularis*, of which *B. magna* is hardly more than a variety.

Hab. On dead wood.—New England, Pennsylvania, Minnesota, Colorado.

8. **B. nitens** Berk. in Trans. Linn. Soc., xxi. 153 (1852) (shining). Plasmodium yellow. Sporangia sessile, subglobose, gregarious or clustered, about 1 mm. diam., sometimes forming plasmodiocarps, orange, yellow, or greenish with yellow warts and ridges ; sporangium-wall membranous, with included clusters of yellow lime-granules. Capillitium yellow or orange, a coarse network of rugged bands, rarely with a few short hyaline threads connecting branched lime-knots ; deposits of lime usually dense, sometimes scanty. Spores purple-brown, in close clusters of 6 to 10, minutely spinulose, coarsely warted on the outer third, 10 to 13 μ diam.—Rost. Mon., App. 3 ; Mass. Mon., 324. Macbr. N. Am. Slime-Moulds, ed. 2, 34. *B. pallida* Berk. l.c. *B. inaurata* Currey in Trans. Linn. Soc., xxiv. 156 (1863).

Var. **reticulata** G. Lister in Trans. Br. Myc. Soc., v. 71 (1914) (forming a net). Sporangia forming simple or branched plasmodiocarps ; spores often less strongly crowned with warts, and less closely clustered.—*B. Alexandrowiczii* Rost. Mon., 146 (1875). *B. decipiens* Lister Mycetozoa, 32 (1894), in part. *Didymium reticulatum* Berk. & Br. in Journ. Linn. Soc., xv. 83 (1876). *Lepidoderma reticulatum* Mass. Mon., 252 (1892).

Pl. 5. *a*, *b*. sporangia ; *c*. capillitium attached to fragment of sporangium-wall and three clusters of spores ; *d*. spore (England).

Examination of the type specimens of *B. nitens* and *B. pallida* from East Bergholt, Essex (Kew 1218, 1235), and of *B. inaurata* from Carlisle (B.M. 151) shows that they are all the same species, with yellow sporangium-walls and closely clustered spores coarsely warted on one side.

Hab. On dead wood and leathery fungi ; var. *reticulata* amongst moss on the trunks of living trees. Not common, but widely distributed in England ; appearing chiefly in winter. Recorded also from N. Ireland, France, Germany, Austria, South Africa, Japan, and the States of Oregon and Colorado : var. *reticulata* recorded from England, Holstein, Poland, Ceylon, Japan, Antigua, Dominica.

9. **B. versicolor** Lister in Journ. Bot., xxxix. 81, tab. 419, fig. 2 (1901) (particoloured). Plasmodium hyaline. Sporangia

subglobose, sessile, minute, 0·3 to 0·5 mm. diam., scattered or in small clusters, grey or flesh-coloured, somewhat rugose ; sporangium-wall membranous with scanty deposits of lime-granules. Capillitium a network of broad or narrow strands charged throughout with lime-granules, white or apricot-coloured. Spores ovoid, 10 × 8 to 12 × 9 μ, arranged in clusters of 10 to 40, forming hollow spheres, dull purple and minutely warted at the broad end, nearly colourless and smooth elsewhere.—Sturgis in Colorado Coll. Publ., Sc. Ser., xii. 13 (1907) ; Macbr. N. Am. Slime-Moulds, ed. 2, 33.

Pl. 6. *a*. sporangia ; *b*. capillitium and clusters of spores with some free spores ; *c*. spore (Scotland).

This minute species appears to be allied on the one hand to *B. capsulifera*, and on the other to *B. nitens*.

Hab. On moss and lichen on trunks of living and dead trees ; appearing regularly in Aberdeenshire from summer to winter : recorded also from Cornwall, from Brandenburg and near Berlin in Germany, from Canton Vaud in Switzerland, from the United Provinces, India, and from Ottawa and Colorado.

10. **B. decipiens** Berk. in Grev., ii. 66 (1873) (deceiving). Plasmodium yellow ? Sporangia sessile, subglobose, or forming curved plasmodiocarps 0·3 to 0·7 mm. diam., scattered, rugose or nearly smooth, yellow or orange ; sporangium-wall membranous with included clusters of yellow lime-granules. Columella none. Capillitium yellow or pale orange, a coarse network densely charged throughout with lime-granules, or formed of large angular and branching lime-knots with few connecting hyaline threads. Spores free, violet-brown, spinulose, often rather paler and smoother on one side, 10 to 13 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 34. *Physarum decipiens* Curt. in Am. Journ. Sc., vi. 352 (1848). *P. chrysotrichum* Berk. & Curt. in Grev., ii. 66 (1873). *Badhamia chrysotricha* Rost. Mon., App. 4 (1876).

Pl. 7. *a*. sporangia (South Carolina ; *legit* Curtis) ; *b*. capillitium and spores with fragment of sporangium-wall ; *c*. spore.

A portion of the type from South Carolina in the British Museum (B.M. 994) has little left for identification, yet some spores and a fragment of sporangium-wall which were scraped off are identical with a good specimen in the Strasb. Herb. sent by Prof. Farlow from Curtis's original gathering. *B. decipiens* is distinguished from *B. nitens* by having free spores. From *Physarum auriscalpium* Cke., the stouter forms of which it closely resembles, the present species differs in the absence of a stalk, in the more complete *Badhamia* character of the capillitium, and usually in the darker spores. MM. Pavillard and Lagarde describe the young sporangia as being first milk-white, then saffron-yellow, and intense green from the purple spores showing through the moist walls ; finally, when dry, the sporangia assume an orange-yellow colour (*see* Bull. Soc. Myc. Fr., xix. 87 (1903)).

Hab. On dead wood and living trees. Recorded from Yorkshire, Aberdeenshire, Sweden, France, Germany, and from New England to Colorado.

11. **B. macrocarpa** Rost. Mon., 143, figs. 118, 120, 121 (1875) (μακρός large, καρπός fruit). Plasmodium white.* Sporangia sessile or stalked, subglobose, scattered, or united in small clusters, 0·5 to 1 mm. diam., white, rugose ; sporangium-wall membranous, varying in the amount of included lime-deposits. Stalk when present firm, about 0·7 mm. long, 0·03 to 0·1 mm. diam., furrowed, yellow or brown with included refuse matter. Capillitium an irregular network of tubes charged throughout with granules of lime, with a few short connecting threads. Spores thick-walled, dark purple-brown, minutely and closely spinulose, 11 to 15 μ diam.—Mass. Mon., 317 ; Macbr. N. Am. Slime-Moulds, ed. 2, 37. *Physarum macrocarpon* Ces. in Rabenh. Fungi Eur., no. 1968 (1854), and in Flora, xxxviii. 271 (1855).

Var. **gracilis** Macbr. N. Am. Slime-Moulds, l.c. (slender). Stalks slender, straw-coloured. Sporangia often umbilicate beneath.

Pl. 8. *a*. sporangia ; *b*. capillitium and spores ; *c*. spore (England).

The var. *gracilis* has been recognized for a number of years, but the name does not appear to have been published until recently. Prof. Macbride refers to it as follows : 'Prof. Bethel finds [the typical form] in winter everywhere on fallen rotting stems of Opuntia and on the bases of dead Yucca leaves still attached. Associated with the typical phase and often occurring alone on the Yucca leaves is a discoidal form which when first sent in (1908) was called var. *gracilis*. Presented alone to one ignorant of its associations it would surely pass for a distinct species. This stalked phase is very delicate ; the stipe pale brown or yellow.'

Hab. On dead wood, frequent in Britain in autumn and winter. Not uncommon throughout Europe and the United States ; recorded also from Japan : var. *gracilis* has been found in the West Indies, and the States of Arizona, Colorado, and California.

12. **B. affinis** Rost. Mon., 143 (1873) (related). Plasmodium whitish then cream-coloured. Sporangia scattered or loosely clustered, hemispherical, somewhat depressed, flattened or umbilicate beneath, about 0·5 mm. diam., greyish-white, smooth or rugulose, stalked or sessile. Stalks from 0·1 to 0·7 mm. long, black, or black below and white above, furrowed. Capillitium a network of tubes containing white lime-granules. Spores violet-brown, closely and minutely spinulose, 10 to 15 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 35.

Var. **orbiculata** G. Lister (circular). Sporangia discoid, often concave above, or forming flattened plasmodiocarps ; capillitium usually consisting of almost simple rod-like tubes. —*B. orbiculata* Rex in Proc. Acad. Nat. Sci. Phil. (1893), 372 ; Lister Mycetozoa, ed. 2, 37 ; Macbride l.c. 37.

Pl. 8. *d*. sporangia ; *e*. *f*. spores.

* Constantineanu describes the colour of the plasmodium as yellow (Ann. Myc. iv. 512 (1906)).

The type specimen from Chili appears to be lost; Prof. Macbride, however, finds North American gatherings agreeing so perfectly with Rostafinski's description that he has felt justified in naming them *B. affinis*. A series of gatherings made by Mr. Kumagusu Minakata in Japan shows every gradation between typical hemispherical sporangia and the flat discoid sporangia of var. *orbiculata*, which is probably the commoner form. Mr. A. R. Sanderson, writing from Petaling, Fed. Malay States, describes var. *orbiculata* as being 'abundant on the wet side of coco-nut palms'.

Hab. On moss and bark on dead and living trees, Cornwall, Aberdeenshire, South Africa, Japan, Malay Peninsula, the United States and West Indies: var. *orbiculata* Malaya, Japan, the United States, and Antigua.

13. **B. panicea** Rost. in Fuckel Symb. Myc., Nachtr. ii. 71 (1873) (made of bread, from the appearance of the sporangia after the spores are shed). Plasmodium white. Sporangia subglobose, 0·4 to 1·2 mm. diam., scattered, or closely aggregated and angled by mutual pressure, white or cinereous, sessile, seated on a dark red hypothallus, rarely with a short dark-red stalk; sporangium-wall membranous, with included deposits of lime-granules in dense clusters forming raised warts or veins. Capillitium white, a profuse network of broad or narrow tubes, charged with granules of lime, often densely confluent at the base and forming an ivory-white columella, sometimes with a few hyaline connecting threads. Spores violet-brown, very minutely warted, 11 μ diam.—Rost. Mon., 144, figs. 114, 116; Mass. Mon., 318; Macbr. N. Am. Slime-Moulds, ed. 2, 35. *Physarum paniceum* Fr. Syst. Myc., iii. 141 (1829). *Badhamia verna* Rost. l.c. 145, in part. *Reticularia* Schmitzii Debey in Verh. Nat. Hist. Ver. Preuss. Rheinl., ii. figs. 1–4 (1847).

Var. **heterospora** G. Lister (Gr. different spore). Spores darker, purplish-brown, paler on one side.

Pl. 10. *a*. sporangia; *b*. capillitium and spores; *c*. spore (England).

When the sporangia are shortly stalked, this species shows a marked affinity to *Physarum pusillum* (q.v.). The hypothallus is usually dark red, but is sometimes pale yellow. The specimen from Freiburg named by Rostafinski *B. verna* (B.M. 1189) appears to be a form of *B. panicea* with scanty lime. The var. *heterospora* has been found repeatedly in the State of Colorado.

Hab. On bark and dead wood, frequent in the British Isles, Europe and the United States; recorded also from Argentina.

14. **B. ovispora** Racib. in Rozpr. Mat.-Przyr. Akad. Krak., xii. 72, tab. 4, fig. 2 (1884) (*ovum* egg, σπορά spore). Plasmodium ? Sporangia white or pale ochraceous, smooth or rugose, hemispherical, 0·5 mm. diam., or forming irregular and often branching plasmodiocarps, crowded or scattered, sometimes seated on a dark-red hypothallus; sporangium-wall thick but friable from the dense deposits of lime-granules. Capillitium white, fragile, consisting of an irregular network of tubes filled with loosely adhering lime-granules, often uniting to form a columella at the base of the sporangium.

Spores free, purple-brown, ellipsoid, 10 × 8 to 16 × 10 μ, smooth, traversed lengthwise by a low ridge or fold marking the line of dehiscence.—Macbr. N. Am. Slime-Moulds, ed. 2, 33.

Pl. 12. *a*. sporangia ; *b*. capillitium and spores ; *c*. spore (Bedfordshire).

This minute species has been found repeatedly, and in some years very abundantly, on heaps of old straw during the months of August and September in the counties of Bedfordshire and Hertfordshire since 1897, when the first British gathering was made by Mr. James Saunders. It has twice appeared on rabbit pellets, in cultures made by Dr. Jahn, in the Botanical Institute, Berlin ; Dr. W. C. Sturgis writes of its occurring on a culture of old straw, from the State of Massachusetts.

Hab. On dead wood lying on the edge of water, on old straw and rabbit pellets ; not common. Bedfordshire and Hertfordshire ; Triglitz and near Berlin, Germany ; Poland ; New England and Pennsylvania.

15. **B. lilacina** Rost. Versuch., 10 (1873). (Mod. L. lilac). Plasmodium bright yellow. Sporangia subglobose, about 0·5 mm. diam., sessile, rarely shortly stalked, gregarious, or crowded and angled by mutual pressure, smooth, flesh-colour or whitish ; sporangium-wall opaque from included deposits of lime. Capillitium flesh-coloured or nearly white, a rugged network with large nodes of irregular shape densely charged with lime-granules, and with a few hyaline connecting threads, often confluent in the centre and forming a pseudo-columella. Spores dark purple-brown, more or less reticulated with prominent, often confluent warts and ridges, 10 to 15 μ diam. —Rost. Mon., 145, figs. 108, 109 ; Macbr. N. Am. Slime-Moulds, ed. 2, 42. *Physarum lilacinum* Fr. Syst. Myc., iii. 141 (1829). *P. concinnum* Mass. Mon., 308 (1892). *Craterium lilacinum* Mass. l.c. 271.

Pl. 13. *a*. sporangia ; *b*. capillitium and spores ; *c*. spore (Pilmoor, Yorks).

Prof. Macbride describes this species as common in the eastern U.S.A. In Britain it appears to be less frequent, though the small pink sporangia when maturing among grass and *Sphagnum* may easily escape detection.

Hab. On dead wood, moss and lichen in swampy places, appearing in Britain in autumn ; not common : Bedfordshire, Yorkshire, Shropshire, N. Wales, Scotland, France, Sweden, Germany, Switzerland, North America.

16. **B. rubiginosa** Rost. Mon., App. 5, fig. 115 (1876) (rusty). Plasmodium bright yellow. Sporangia scattered and in loose clusters, obovoid, stalked, rarely sessile, 0·5 mm. broad, pale rufous or purplish-brown, usually paler above, the upper part of the wall breaking away in fragments from the more persistent lower part ; sporangium-wall purplish, membranous, more or less charged with granules of lime. Stalk cylindrical or widening at the base, usually about the length of the sporangium, smooth, reddish-brown, continued within the sporangium to more than half its height as a pale clavate or cylindrical columella, often containing calcareous nodules. Capillitium a white or pale rufous rugged network,

usually densely charged with lime-granules, spreading from all parts of the columella to the sporangium-wall, sometimes with a few hyaline connecting threads. Spores dark purplish-brown, minutely spinulose, 11 to 15 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 43. *Physarum rubiginosum* Chev. Fl. Par., 338 (1826). *Scyphium rubiginosum* Rost. Mon., 148 (1875). *Craterium rubiginosum* Mass. Mon., 270 (1892). *Didymium Curtisii* Berk. in Grev., ii. 65 (1873). *Badhamia Curtisii* Rost. Mon., App. 5 (1876). *B. subaquila* Macbr. N. Am. Slime-Moulds, 64 (1899). *Craterium Curtisii* Mass. l.c. 272. *Craterium obovatum* Beck in Rep. New York Mus., xxvi. 75 (1874).

Var. **dictyospora** Lister Mycetozoa, 35 (1894) (δίκτυον net, σπορά spore). Sporangia obovoid ; spores marked with prominent often confluent warts forming a broken reticulation.—*Badhamia dictyospora* Rost. l.c. 4. *Craterium dictyospermum* Mass. l.c. 270.

Var. **globosa** Lister in Journ. Bot., xlii. 130 (1904). Sporangia subglobose, 0·7 mm. diam., purplish-grey ; stalk dark brown, 0·5 to 1 mm. long ; columella dark brown, clavate ; spores strongly reticulated and warted.—*Diderma Hookeri* Berk. in Fl. Nov. Zel., 191 (1855) ? *Lamproderma Hookeri* Rost. Mon., App. 24 (1876) ? *Diachaea Hookeri* Mass. l.c. 260. *Chondrioderma Hookeri* Lister Mycetozoa, 85 (1894) ?

Pl. 14. *a*. sporangia ; *b*. spore (Philadelphia) ; *c*. sporangia of var. *dictyospora* ; *d*, *e*. capillitium and spores of same (Epping Forest) ; . sporangia of var. *globosa* ; *g*. spore of same (N. Wales).

Although this species is not very common in Britain, the sporangia usually occur in large colonies. The type of *Didymium Curtisii* Berk. from South Carolina (B.M. 406) differs from typical *B. rubiginosa* only in being sessile or shortly stalked. The type of *B. subaquila* Macbr. from Maine (B.M. 3184) is similar, but has completely sessile sporangia on a stout purplish hypothallus ; in both British and American gatherings of *B. rubiginosa*, however, the length of the stalk is subject to great variation, and the sessile character alone would not appear to constitute a specific difference. The typical form of the present species with minutely spinulose spores is very abundant in the United States, but does not appear to be common in Europe, and has not yet been obtained from the British Isles. The var. *globosa* has been obtained from various parts of England, from Wales, and Ireland, always occurring on moss and ferns growing on wet rocks. The resemblance which these gatherings bear to the unsatisfactory type of *Diderma Hookeri* Berk. (K. 1559), from New Zealand, is very striking. In the latter specimen the sporangia are studded over the leaves of a species of *Hymenophyllum*, and were evidently much weathered at the time of collection ; hardly any spores remain, and even these may possibly have been introduced from external sources ; the few slender bases of capillitium threads springing from the stout columella strongly resemble those about the columella of *B. rubiginosa* var. *globosa*, in some forms of which the capillitium is often very slender and contains little or no lime. Although complete proof of the identity of *Diderma Hookeri* and *B. rubiginosa* var. *globosa* cannot perhaps now be obtained, the probability that they are the same form is strong. (*See* Journ. Bot., xliii. 151 (1905).)

Hab. On fallen leaves and brushwood in autumn and winter; var. *globosa* on moss on rocks. The typical form has been recorded from France, Germany, Moldavia, and the United States and Canada: var. *dictyospora*, England, France, Germany, Portugal, South Africa, Japan: var. *globosa*, Great Britain and Ireland, Holstein, Sandwich Islands.

17. **B. viridescens** Meylan in Bull. Soc. Vaud. Sc. Nat., liii. 452 (1921) (becoming green). Plasmodium yellow. Sporangia scattered or loosely clustered, stalked, subglobose, 0·5 to 0·8 mm. diam., yellow, or grey with a yellow base, rugulose; sporangium-wall closely spotted and veined with deposits of lime-granules, thicker and orange-yellow near the base. Stalk yellow, or yellowish-red, sulcate, free from refuse deposits, 0·1 to 0·3 mm. high. Capillitium a network of tubes enclosing pale yellow or white lime-granules, with a few connecting hyaline threads. Spores pale brownish-violet, very minutely warted, 9 to 13 μ diam.

This species closely resembles the form of *Craterium aureum* with globose sporangia, from which it differs in the character of the capillitium and the larger paler spores. Mr. Ch. Meylan has found it in several localities in the Jura Mts. at an altitude of from 700 to 1,200 metres.

Hab. On lichen and bark on fallen branches, in summer and autumn. Cawdor, Scotland; Jura Mountains.

Genus 3.—**PHYSARUM** Persoon in Usteri Ann. Bot., xv. 5 (1795) (φῦσα bubble, from the appearance of the sporangium). Sporangia stalked, sessile or forming plasmodiocarps; sporangium-wall either single, or consisting of two more or less separable layers, with deposits of minute rounded lime-granules distributed in loose or dense clusters or compacted into a crust. Stalk membranous, tubular (except in *P. penetrale* in which the stalk is solid and translucent), wrinkled with longitudinal folds, either translucent, or opaque with deposits of lime or refuse matter in the wall-substance or in the cavity of the tube. Capillitium forming a network of hyaline threads with vesicular expansions containing calcareous deposits (lime-knots), occasionally, in weak forms, without such deposits.

The genus *Tilmadoche* is described by Rostafinski (Mon., 126) as differing from *Physarum* in the capillitium forking repeatedly at a narrow angle, and being provided with few and small lime-knots. These characters are too inconstant to be of value in classification. In *P. nutans* Pers. which from its abundance affords ample facility for study, we not infrequently observe in a growth from one plasmodium some sporangia with capillitium characteristic of *Physarum* and others of *Tilmadoche*. For these reasons the genus *Tilmadoche* is not retained.

KEY TO THE SPECIES OF *PHYSARUM*.

A. Sporangia stalked (occasional sessile forms) :—

A. Stalks charged with lime throughout—

a. Capillitium lax—

Stalk white ; sporangia grey ; lime-knots large white ; columella none. 1. *P. leucopus*

Stalk white, rarely yellow or rufous ; sporangia tawny, globose ; columella conical. 2. *P. melleum*

Stalk white or yellow ; sporangia sulphur- or olive-yellow ; columella none. 3. *P. sulphureum*

Stalk and sporangium yellow or orange ; columella large, hemispherical. 4. *P. luteo-album*

b. Capillitium dense, persistent—

Stalk white, or brownish below ; sporangium white ; lime-knots small, white. 5. *P. globuliferum*

Stalk, sporangium, and lime-knots red. 6. *P. pulcherripes*

Stalk, sporangium, and lime-knots mouse-brown. 7. *P. murinum*

Stalk, sporangium, and lime-knots purple. 8. *P. pulcherrimum*

Stalk, sporangium, and lime-knots lilac or pale blue. 9. *P. lilacinum*

Stalk, sporangium, and lime-knots yellow ; robust. 10. *P. citrinum*

Stalk, sporangium, and lime-knots straw-coloured, slender. 11. *P. tenerum*

Stalk and sporangium white ; capillitium with a central ball of lime. 12. *P. columbinum*

Stalk ochraceous, often absent ; sporangium white, ovoid or cylindrical, with a long pseudo-columella, or forming plasmodiocarps ; lime-knots white. 13. *P. mutabile*

B. Stalks without lime, or with deposits in the wall only—(*See also* 13).

α. Lime-knots purple-red ; sporangium rose-red. 14. *P. roseum*

β. Lime-knots and sporangium violet-purple. 15. *P. Newtoni*

γ. Lime-knots orange ; sporangium glossy, mottled blue and red ; stalk red or orange. 16. *P. psittacinum*

δ. Lime-knots orange ; sporangium bronze ; stalk black ; spores reticulated. 17. *P. dictyospermum*

ε. Lime-knots yellow or orange ; sporangia yellow, orange, or grey—

Sporangia subglobose or lenticular, on usually slender stalks ; lime-knots fusiform, rarely angular ; spores pale. 18. *P. viride*

Sporangia lenticular, with rod-like lime-knots, and purplish-brown spores. 19. *P. rigidum*

Sporangia contorted, stalked, usually adhering in clusters ; capillitium lax ; lime-knots fusiform. 20. *P. polycephalum*

Sporangia subglobose, yellow or iridescent bronze ; stalks red-brown ; capillitium dense, persistent ; lime-knots angular, small. 21. *P. flavicomum*

Sporangia globose on slender yellow stalks ; lime-knots angular. 22. *P. galbeum*

Sporangia subglobose or obovoid, yellow with a reddish base ; lime-knots angular, large. 23. *P. Maydis*

Sporangia subglobose, orange ; stalks brown, short or absent ; lime-knots large and branching. 24. *P. auriscalpium*

Sporangia subglobose, pale yellow ; stalks when present membranous. 25. *P. fulvum*

Stalk red, solid, penetrating the sporangium for four-fifths of its height. 26. *P. penetrale*

ζ. Lime-knots white, sporangia yellow or brown—

Sporangia subglobose, yellow, rugose ; stalks red. 27. *P. citrinellum*

Sporangia subglobose, pale yellow ; stalks flesh-coloured. 28. *P. carneum*

Sporangia brown, smooth, shining ; stalks when present red. 29. *P. brunneolum*

η. Lime-knots white ; sporangia grey or white—

* Stalk free from refuse matter—

Stalk straw-coloured ; sporangium globose ; capillitium with a central ball of lime. 30. *P. nucleatum*

Stalk straw-coloured, slender ; sporangia compressed ; spores marked with patches of warts. 31. *P. straminipes*

Stalk red-brown ; sporangia globose, white. 32. *P. pusillum*

Stalk white, membranous, short, or absent ; sporangia ovoid, or subglobose (and then sessile).
33. *P. didermoides*

** Stalk containing refuse matter—

Stalk buff, black, or white, often absent ; sporangia subglobose ; spores brownish-violet.
34. *P. nutans*

Stalk white or yellowish, sporangia discoid, often umbilicate above, spores brownish-violet.
35. *P. javanicum*

Stalk black, or black below, white above ; sporangia ovoid or subglobose, usually with a long columella ; spores dull lilac. 36. *P. crateriforme*

Stalk black, buff, or white, stout ; sporangia compressed, often lobed ; lime-knots rounded ; spores dark purple-brown. 37. *P. compressum*

Stalk brown or white ; sporangia subglobose ; lime-knots angular ; spores dark purple-brown.
38. *P. connatum*

Stalk black ; sporangia subglobose or discoid ; spores nearly black with a paler spot.
39. *P. melanospermum*

Stalk yellowish or dark, slender ; sporangia compressed and lobed, often clustered (smaller than *P. compressum*, to which it is very nearly allied).
40. *P. reniforme*

B. Sporangia sessile, never stalked :—(For occasional sessile forms, *See* 13, 24, 25, 29, 31, 33, 34, 37.)

A. Lime-knots white—

a. Sporangium-wall single—

Sporangia subglobose or forming plasmodiocarps, white or grey ; spores pale brownish-violet, 7–10 μ diam. 41. *P. cinereum*

Sporangia subglobose, dark grey, heaped, the walls usually with scanty or no lime deposits, spores brownish-violet, 10–11 μ diam.
42. *P. confertum*

Sporangia subglobose or forming plasmodiocarps ; white, or grey, spores purplish-brown, 9–11 μ diam.
43. *P. vernum*

Sporangia white, forming plasmodiocarps ; spores purplish-brown marked with a pale line, often oval. 44. *P. ovisporum*

Sporangia yellow, white, or orange, forming plasmodiocarps ; lime-knots rounded. 45. *P. sessile*

Sporangia much compressed, forming rosettes or net-like plasmodiocarps ; lime-knots fusiform.
46. *P. gyrosum*

Sporangia small, crowded, chestnut-brown.
47. *P. Famintzini*

b. Sporangium-wall double—

* Sporangia scattered, forming plasmodiocarps—

Plasmodiocarps sinuous, much compressed, white ; spores marked with strong ridges and spines, brownish-purple. 48. *P. echinosporum*

Plasmodiocarps sinuous, much compressed, white or buff ; inner wall fragile, colourless ; spores purple-brown, spinulose. 49. *P. sinuosum*

Plasmodiocarps sinuous, buff or brown, marked with pale lines of dehiscence ; spores pale brownish-violet, nearly smooth. 50. *P. bogoriense*

Plasmodiocarps white, usually compressed ; inner wall purplish, persistent ; spores dark purplish-brown, spinulose. 51. *P. bitectum*

** Sporangia crowded, reniform or subglobose—

Sporangia white, subglobose, outer wall shell-like.
52. *P. testaceum*

Sporangia yellow ; spores dark, rough, 10–14 μ.
53. *P. contextum*

Sporangia yellow ; spores pale, nearly smooth, 8–10 μ. 54. *P. conglomeratum*

B. Lime-knots yellow, red, or brown—

Slender plasmodiocarps and large branching lime-knots yellow. 55. *P. Serpula*

Plasmodiocarps and lime-knots brown.
56. *P. aeneum*

Sporangia red or brownish-buff ; lime-knots large, angular, orange-red or red-brown.
57. *P. rubiginosum*

Sporangia red ; lime-knots rounded, yellow, often with red centres. 58. *P. lateritium*

Sporangia yellow or orange, with single walls ; lime-knots angular, yellow. 59. *P. virescens*

Sporangia clay-coloured, subcylindrical, clustered ; lime-knots clay-coloured. 60. *P. digitatum*

Plasmodiocarps stout, yellow or buff, with double walls ; lime-knots large, yellow, angular.
61. *P. alpinum*

1. P. leucopus Link in Mag. Ges. Nat. Fr. Berl., iii. 27 (1809)

(λευκός white, πούς foot). Plasmodium opaque-white or yellowish. Total height about 1 mm. Sporangia globose, greyish-white or glaucous, 0·5 mm. diam., loosely clustered, stalked, rarely almost sessile ; sporangium-wall membranous, containing scattered or clustered lime-granules. Stalk white, stout, 0·15 to 0·2 mm. thick, with a few shallow longitudinal furrows, erect, rigid, brittle, somewhat narrowing upwards, chalk-white in section to the base from the enclosed lime-granules, rising from a more or less developed white hypothallus. Columella none. Capillitium consisting of delicate branching hyaline threads connecting large irregular white lime-knots ; lime-granules 1 to 1·5 μ diam. Spores violet-brown, minutely spinulose, 7 to 10 μ diam.—Rost. Mon., 101 ; Mass. Mon., 287 (in part) ; Macbr. N. Am. Slime-Moulds, ed. 2, 79. *P. bullatum* Link l.c. ; Ditm. in Sturm Deutsch. Fl., Pilze, 45, t. 22. *Didymium leucopus* Fr. Syst. Myc., iii. 121 (1829).

Pl. 15.—*a*. sporangia ; *b*. capillitium with fragment of sporangium-wall and spores *c*. spore (England).

The stout white stalk distinguishes *P. leucopus* from *P. nutans*, where the stalk almost always contains dark refuse matter, while the loose network of the capillitium and large lime-knots separate it from *P. globuliferum*. Sporangia sometimes occur having more slender buff or pale brown stalks in company with others having the usual white colour.

Hab. On dead leaves, in autumn and winter, not common. Recorded from Hertfordshire, Sussex, Dorset, Devon, Somerset, Shropshire and Yorkshire in the British Isles ; from France, Germany, Sweden, Switzerland, Roumania and Portugal ; from several of the United States, from New Granada, and from Java.

2. **P. melleum** Mass. Mon., 278 (1892) (*mel* honey). Plasmodium yellow. Total height 0·8 mm. Sporangia globose, stalked, erect, yellow or brownish-yellow, 0·5 mm. diam. ; sporangium-wall membranous, often wrinkled, persistent at the base, yellowish, with deposits of minute yellow lime-granules. Stalk white, buff, yellow, or rufous, stout, opaque, with few shallow furrows, chalky in section. Columella short, conical. Capillitium consisting of irregularly-branching delicate hyaline threads, often expanded at the axils, with lime-knots white or yellow, various in shape and size, mostly large and angled. Spores violet-brown, almost smooth, 7 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 65. *Didymium melleum* Berk. & Br. in Journ. Linn. Soc., xiv. 83 (1873). *Physarum Schumacheri*, var. *β melleum* Rost. Mon., App. 7 (1876). *P. Kalchbrenneri* Mass. l.c. 297. *P. rubropunctatum* Pat. in Bull. Soc. Myc. Fr., ix. 143 (1893) ? *P. tucumanense* Speg. in Rev. Agr. Veter. la Plata (1896), 237 ? *Didymium chrysopeplum* Berk. & Curt. in Grev., ii. 53 (1873). *Cytidium melleum* Morg. in Journ. Cinc. Soc. Nat. Hist., xix. 11 (1896).

Pl. 23.—*a*. sporangia ; *b*. capillitium and spores ; *c*. spore (Philadelphia).

The form of this species with yellow stalks closely resembles *P. citrinum* Schum., but differs in the loose fragile network of the capillitium and the large angular lime-knots.

Hab. On dead wood. In Europe recorded from Portugal, Bohemia and Moldavia; not uncommon in the United States, and abundant throughout the tropics; recorded also from South Africa, S. Australia, and Japan.

3. **P. sulphureum** Alb. & Schw. Consp. Fung., 93, tab. 6, fig. 1 (1805). Plasmodium ? Sporangia subglobose or pyriform, rugulose, sulphur- or olive-yellow, gregarious, 0·5 to 0·8 mm. diam., stalked; sporangium-wall membranous, with crowded clusters of yellow lime-granules. Stalk stout, white, dirty white, yellowish or yellowish-brown, 0·1 to 0·3 mm. high, furrowed, densely charged with lime within. Columella none. Capillitium with abundant large, irregular, often branching and confluent white or yellow lime-knots, and rather short connecting threads. Spores violet-brown, spinulose, 9 to 11μ diam.—Rost. Mon., 101; Macbr. N. Am. Slime-Moulds, ed. 2, 84. *P. flavum* Fr. Symb. Gast., 22 (1818); Rost. l.c. 100. *P. lepidodermoides* Blytt in Bidr. Norg. Sop., iii. 4 (1892). *P. variabile* Rex in Proc. Acad. Nat. Sci. Phil. (1893), 371. *Craterium flavum* Fr. Sum. Veg. Scan., 454 (1849).

Pl. 65.—*a*. sporangia; *b*. capillitium and spores, with fragment of sporangium-wall; *c*. spore (Sweden). Pl. 21.—*a*. sporangia; *b*. capillitium and spores; *c*. spore (New York).

Specimens gathered by Dr. R. E. Fries from near Upsala correspond exactly with the illustration of the type in Consp. Fung., l.c. The graphic description of *P. flavum* Fr., with its rugose but glossy (*glaberrima*) yellow sporangia and short yellowish-white furrowed stalks, applies well to the present species. In *Systema Mycologicum*, p. 135, Fries places *P. flavum* next after *P. sulphureum*; the distinctions he makes between the two species are the bright yellow rather than sulphur-coloured sporangia and yellow not white stalks of *P. flavum*; sporangia showing varying shades of brightness, with white or yellowish stalks, may however occur in a single group of *P. sulphureum*. The type of *P. lepidodermoides* Blytt from Rollag, Telemarken, on moss (B.M. slide), has subglobose stalked sporangia, 0·7 to 0·8 mm. diam.; the sporangium-wall breaks up into shining convex pale brown scales, densely charged with deposits of lime; there is no columella; the stalks are 0·5 mm. high, stout, furrowed, broader at the base, cream-white, without lime-deposits; the capillitium consists of large irregular shrunken whitish lime-knots connected by branching hyaline threads; the spores are purple-brown, spinulose, 9 to 11μ diam.; the scales of the sporangium-wall and the shrunken lime-knots suggest that this is not a perfect development; probably it is a form of *P. sulphureum*, in which we have met with some sporangia having almost no lime in the stalk associated with others whose stalks are rich in lime. *P. lepidodermoides* bears some resemblance to *P. citrinellum* Peck, but the stalks are cream-white, not orange-red as in the latter species. Gatherings of *P. sulphureum* made by Dr. W. C. Sturgis in Colorado show a considerable variety of colour and form in a single development, including the typical form with yellow globose sporangia and white stalks, and more or less ovoid olivaceous sporangia on brownish-yellow stalks; the latter variety corresponds to *P. variabile* Rex, which is thus found to be merely a dull-coloured form of

P. sulphureum. The var. *sessile* Lister of *P. variabile* is now promoted to specific rank (see *P. sessile*).

Hab. On dead leaves and the under side of fir bark. Sweden, North Germany, Austria, Moldavia, Japan, North and South America.

4. **P. luteo-album** Lister in Journ. Bot., xlii. 130, Pl. 459, fig. 2 (1904) (yellow-white). Plasmodium orange. Sporangia stalked, gregarious, subglobose, about 1 mm. broad, 0·7 mm. high, yellow shading into white, deep orange or olivaceous, smooth or rugulose ; sporangium-wall pale yellow or orange, with dense or scanty deposits of yellow lime-granules. Stalk stout, smooth, 0·5 to 1 mm. long, 0·2 mm. thick, bright yellow or orange above, nearly white below, either cylindrical and densely charged with lime-granules throughout, or narrowed towards the base and the lime there in the form of crystalline nodules. Columella large, subglobose or shortly clavate, pale yellow or orange. Capillitium either of very slender pale yellow threads, branching at acute angles and anastomosing, or of broad yellow simple or forked strands, persistent after the dispersion of the spores ; lime-knots either small, yellow, linear, or large and rounded. Spores purple-brown, strongly spinulose, 10 to 12 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 71.

Pl. 24.—*a*. sporangia ; *b*. capillitium and spores ; *c*. spore (Ventimiglia).

This well-marked species was first gathered in January, 1903, by Miss Constance Pim, who found about twenty pale yellow sporangia on pine needles, in the gardens of Sir T. Hanbury, La Mortola, Ventimiglia. Since then a form agreeing in all essentials with the type, but with orange or olive-coloured sporangia, has been found in abundance on the shores of the Kolksee, E. Holstein, by Herr H. Rönn, in an alder wood, in the winter of 1909–1910. The same form has appeared repeatedly near Lyme Regis on dead alder and bramble leaves, and also near Porlock, Somerset. In these gatherings the sporangia are either scattered or united in pairs ; the sporangium-walls have usually scanty deposits of lime, and readily fall away, leaving a collar-like rim round the base of the columella, and exposing the persistent brush of yellow capillitium ; the lime-knots are usually very slender, and often consist merely of a row of lime-granules enclosed in a thread of the capillitium ; the strongly spinulose spores are rather paler than in the La Mortola specimen. A gathering on dead wood, made by Mrs. J. Drake at Kotgarh, north-east of Simla, in 1912, has the stalks and sporangia more or less confluent ; the cartilaginous orange walls break up into areolae ; the columellae are rugged and irregularly lobed, and the capillitium contains many rounded pale yellow lime-knots.

Hab. On pine needles, dead leaves, twigs, &c., from autumn to spring. Recorded from Devon and Somerset ; from France, North Italy, Holstein, North-west India, and Colorado.

5. **P. globuliferum** Pers. Syn. Fung., 175 (1801) (*globulus* globule, *fero* I bear). Plasmodium pale yellow. Total height 0·6 to 1·5 mm. Sporangia gregarious or united in small clusters, globose, stalked, erect, white, 0·5 mm. diam. ; sporangium-wall membranous, with crowded clusters of included lime-granules. Stalk white or pale buff, sometimes red-brown towards the

base, 0·1 to 1 mm. long, 0·01 to 0·05 mm. thick, nearly smooth, brittle, chalky in section. Columella conical. Capillitium persistent, retaining the form of the sporangium after the dispersion of the spores, forming a close network of widely branching hyaline threads with numerous fusiform or rounded white lime-knots 10 to 20 μ diam. Spores lilac-brown, almost smooth, 6 to 8 μ diam.—Rost. Mon., 98, fig. 86, Mass. Mon., 297 ; Macbr. N. Am. Slime-Moulds, ed. 2, 66. *Sphaerocarpus globulifer* Bull. Champ., 134, t. 484, fig. 3 (1791). *Stemonitis globulifera* Gmel. Syst. Nat., ii. 1469 (1791). *Trichia globulifera* DC. Fl. Fr., ii. 253 (1805). *Diderma globuliferum* Fries Syst. Myc., iii. 100 (1829). *Physarum Petersii* var. *Farlowii* Rost. Mon., App. 6 (1876). *P. albicans* Peck in Rep. New York Mus., xxx. 50 (1878) ; Mass. l.c., 312. *Physarum columbinum* Macbr. in Bull. Nat. Hist. Iowa, ii. 384 (1893). *P. relatum* Morgan in Journ. Cinc. Soc., xix. 26 (1896). *P. delicatissimum* Speg. in Anal. Mus. Nac. Buen. Aires, vi. 199 (1899) ? *Didymium subroseum* Peck l.c., xxviii. 54 (1879). *D. longipes* Mass. l.c., 236 (1892) ? *Cytidium globuliferum* Morg. l.c., 10.

Pl. 16.—*a*. sporangia ; *b*. capillitium and spore ; *c*. spore (Philadelphia).

The types of *P. Petersii* var. *Farlowii* Rost., and *P. albicans* Peck are the same species as the *P. globuliferum* in the Strasburg collection. *P. columbinum* Macbride, from Iowa (B.M. 1012), is also *P. globuliferum* ; it has snow-white, occasionally red-brown, stalks, and well-developed conical columellae. In a specimen from Dr. Rex (B.M. 1202) marked by him '*P. Petersii* var. *Farlowii*, conglobate form', the sporangia are in clusters of from 6 to 14 together. Prof. Macbride has seen the type of *P. relatum* Morg., and considers it to be a delicate form of the present species. British specimens have larger sporangia than in the typical form, and are either stalked or sessile ; they are rarely pure white, and show an affinity to *P. murinum*.

Hab. On dead wood. Not common in the British Isles, recorded from Surrey, Cumberland, and Aberdeenshire ; Dr. Brandza finds it fairly common in Moldavia ; recorded also from Sweden, France, Germany, Switzerland, Russia, from Borneo, Java, New Zealand, the Bonin and Friendly Islands, Japan, and North and South America.

6. **P. pulcherripes** Peck in Bull. Buffalo Soc. N. Hist., i. 64 (1873) (*pulcher* beautiful, *pes* foot). Plasmodium ? Total height 1 to 2 mm. Sporangia stalked, globose, yellow-orange, orange-red or dark brown, sometimes grey from the absence of lime, about 0·5 mm. diam. ; sporangium-wall membranous, with deposits of lime usually abundant, sometimes scanty. Stalk vermilion-red or red-brown, 0·5 to 1·5 mm. long, 0·1 mm. thick, somewhat narrowed upwards, densely charged with red or brown lime-granules or crystalline nodules, brittle. Columella conical or subglobose. Capillitium with red or reddish-brown lime-knots, hyaline threads as in *P. globuliferum*. Spores violet-brown, almost smooth, 6 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 69. *P. pulchripes* Berl. in Sacc. Syll.,

vii. 349 (1888); Mass. Mon., 315. *P. Petersii* Berk. & Curt. in Grev., ii. 66 (1873); Mass. l.c., 295 (in part). *P. psittacinum* var. *Ravenelii* Rost. Mon., App. 8 (1876). *P. Ravenelii* Mass. l.c., 281. *P. rufipes* Macbr. l.c., ed. 1, 50 (1899). *Didymium erythrinum* Berk. in Grev., ii. 52 (1873); Mass. l.c., 249. *D. Ravenelii* Berk. & Curt. l.c., 53. *Cytidium rufipes* Morg. in Journ. Cinc. Soc. Nat. Hist., lxix. 9 (1896).

Pl. 17.—*a*. sporangia; *b*. capillitium and spores; *c*. spore (Philadelphia).

A frequent species in the United States, differing from *P. globuliferum* chiefly in the red colour of the lime. The specific name *rufipes* had its origin in *Physarum aurantiacum* β *rufipes* Alb. & Schw. (Consp. Fung., 94, (1805)), = *Diderma rufipes* Fr. Syst. Myc., iii. 101 (1829), = *P. Schumacheri* var. *rufipes* Rost. Mon., App. 7. The single German gathering described under these names has long since disappeared; in the original description Albertini and Schweinitz make no mention of the presence or absence of lime in the stalk; the sporangia are said to be globose or obovate, to be provided with a spurious central columella, and to have been found 'on a heap of dead leaves, twigs, etc.'; these characters are not appropriate to *P. pulcherripes*, a species which appears always on dead wood, and has been recorded hitherto with certainty only from the United States and North Ireland. What *P. aurantiacum* β *rufipes* Alb. & Schw. really was remains a matter for conjecture; Rostafinski states that he had not seen the type specimen. It would seem better therefore to drop the specific name *rufipes*. The type of *Didymium erythrinum* Berk. (K. 1265) is somewhat immature, but shows the opaque red-brown stalks densely charged with lime throughout characteristic of *P. pulcherripes*; it was wrongly placed by Rostafinski under *P. psittacinum*, a species without columella, and with translucent stalks free from lime-granules. The type of *Didymium Ravenelii* Berk. & Curt. from North Carolina (B.M. 1738) is a form of the present species with red-brown stalks, columellae and lime-knots. The type of *P. Petersii* Berk. & Curt. from Alabama (K. 1254) is also identical with *P. pulcherripes*. Peck's name is here adopted as being free from ambiguity.

Hab. On dead wood. Rostrevor, Co. Down; not uncommon in the United States.

7. **P. murinum** Lister Mycetozoa, 41 (1894) (mouse-like, from the brown sporangia). Plasmodium ? Sporangia globose, about 0·5 mm. diam., stalked or sessile, or forming plasmodiocarps, pale pinkish- or greyish-brown, rugose; sporangium-wall membranous, with innate clusters of brown lime-granules. Stalk erect, 0·5 mm. long or shorter, 0·1 mm. thick, of equal breadth throughout, brown, furrowed, containing dense deposits of white or brown lime-granules. Columella present only in the stalked forms, conical. Capillitium forming either a dense network of obtusely branching hyaline threads, persistent after the dispersal of the spores, with ovoid brown lime-knots, or a looser network of hyaline threads, with numerous elongated irregularly branching lime-knots. Spores pale brownish-lilac, nearly smooth, 8 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 68. *P. Braunianum* Lister in Journ. Bot., xxix. 259 (1891), *non* Rost. *P. heterosporum* Widder in

Verhandl. Zool.-Bot. Gesellsch. Wien, lxxiii. 159 (1923). *Cytidium Ravenelii* Morg. in Journ. Cinc. Soc. Nat. Hist., xix. 10 (1896).

Pl. 18.—*a*. sporangia ; *b*. capillitium and spores ; *c*. spore (Philadelphia).

This species is closely allied on the one hand to *P. globuliferum* and on the other to *P. pulcherripes* ; it is distinguished from both by the pale brown colour of the sporangium, lime-knots and stalk.

Hab. On dead leaves and wood ; North Wales, Wigtonshire, Aberdeenshire, and Co. Down ; Sweden, Germany, Austria, Switzerland, and the United States (*fide* Macbride).

8. **P. pulcherrimum** Berk. & Rav. in Grev., ii. 65 (1873) (most beautiful). Plasmodium dark red. Total height 1 mm. Sporangia stalked, globose, flattened beneath, erect or inclined, reddish-purple or rose-magenta, sometimes copper-iridescent, 0·4 to 0·5 mm. diam., gregarious ; sporangium-wall membranous, pale purple, with scattered clusters of purple globular lime-granules (1 μ diam.). Stalk purple, subulate, 0·5 to 1 mm. long, brittle, containing lime. Columella small, convex, conical or none. Capillitium a close persistent network of delicate purplish threads, broader and more expanded at the axils below ; lime-knots numerous, small, roundish, filled with purple lime-granules. Spores pale dull red, almost smooth, 7 to 8 μ diam.—Rost. Mon., 105, fig. 84 ; Macbr. N. Am. Slime-Moulds, ed. 2, 68. *Stemonitis porphyra* Berk. & Curt. in Grev., ii. 69 (1873). *Physarum atrorubrum* Peck in Rep. New York Mus., xxxi. 40 (1879) ; Mass. Mon., 294. *Cytidium pulcherrimum* Morg. in Journ. Cinc. Soc. Nat. Hist., xix. 8 (1896).

Pl. 19.—*a*. sporangia ; *b*. capillitium and spores ; *c*. spore (Ceylon).

Hab. On dead wood. Ceylon, Malaya, and the United States.

9. **P. lilacinum** Sturgis & Bilgram in Mycologia ix. 324 (1917). (Mod. L. lilac-coloured). Resembling *P. pulcherrimum* in all respects except that the colour of the sporangium, stalk and lime-knots are pale lilac or pale Indian-red, and the spores are pale brown.—Macbr. N. Am. Slime-Moulds, ed. 2, 67.

Var. **coeruleum** G. Lister (blue). Stalk, sporangium and lime-knots pale blue.

These beautiful forms were found by Mr. Hugo Bilgram near Philadelphia ; they present further examples of the colour varieties occurring in the *P. globuliferum* series.

Hab. On dead wood, Fairmount Park, Philadelphia.

10. **P. citrinum** Schumacher Enum. Pl. Saell., ii. 201 (1803) (*citrus* lemon). Plasmodium bright yellow. Total height 0·8 to 2 mm. Sporangia globose, rugose, stalked, rarely nearly sessile, erect, yellow to yellowish grey, 0·4 to 0·7 mm. diam. ; sporangium-wall membranous with included clusters of yellow lime-granules. Stalk golden-yellow, stout, somewhat furrowed, 0·1 to 1·3 mm. long, chalky in section, sometimes enclosing

nodules of lime, often rising from a vein-like hypothallus. Columella short, conical or obtuse. Capillitium a somewhat close network of hyaline rigid threads with flat expansions at the axils, persistent after the dispersion of the spores ; lime-knots yellow, numerous, varying in shape and size, usually rounded. Spores lilac-brown, almost smooth, 7 to 10 μ diam.—Fr. Symb. Gast., 22 ; Macbr. N. Am. Slime-Moulds, ed. 2, 66. *P. compactum* Ehrenb. Syl. Ber., 21 (1818). *P. Schumacheri* Spreng. Sys. Veg., iv. 528 (1827) ; Rost. Mon., 98 (1875) ; Mass. Mon., 275. *P. aureum β chrysopus* Lév. in Ann. Sc. Nat., ser. 3, v. 166 (1846). *P. Schroeteri* Rost. l.c., 419 ? *P. Leveillei* Rost. Mon., App. 7 (1876) in part ; Mass. l.c., 296. *Cytidium citrinum* Morg. in Journ. Cinc. Soc. Nat. Hist., xix. 9 (1896).

Pl. 20.—*a*. sporangia ; *b*. capillitium and spores ; *c*. spore (Bedfordshire).

Rostafinski describes *P. Leveillei* as being closely allied to the present species, but having larger spores, measuring 10 to 11 μ instead of 7 to 8 μ. His type of *P. Leveillei α* from Freiburg, *leg.* de Bary (Strasb. Herb.) is *P. citrinum* with large yellow sporangia and spores 8 μ diam. ; the gathering from Venezuela (K. 1261) quoted by him as *P. Leveillei β auripes* is *P. citrinum* with rather long stalks, and spores measuring 10 μ ; his *P. Leveillei α* from Chili (ex herb. Gay, Paris Herb.) is typical *P. viride*.

Hab. On dead wood and moss, not unfrequent in England and Scotland ; occurring also in France, Belgium, Sweden, Germany, Switzerland, Austria, Moldavia, S. Australia, New Zealand, North and South America.

11. **P. tenerum** Rex in Proc. Acad. Nat. Sc. Phil. (1890), 192 (delicate). Plasmodium primrose-yellow. Total height, 1 to 2 mm. Sporangia globose, stalked, erect or nodding, gregarious, yellow, seldom grey, 0·4 mm. diam. ; sporangium-wall membranous with closely-set rounded clusters of included granules. Stalk subulate, slender, opaque, 0·5 to 1·7 mm. long, pale yellow, and filled with lime above, often darker below from the presence of refuse matter. Columella none. Capillitium of very slender hyaline threads forming a close persistent network, with numerous round or rounded yellow lime-knots, the axils of the branches slender and mostly free from lime. Spores brownish-lilac, nearly smooth, 7 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 92. *P. maculatum* Macbr. in Bull. Lab. Nat. Hist. Iowa, ii. 383 (1893) ; Macbr. N. Am. Slime-Moulds, ed. 2, 77. *P. obrusseum* Macbr. N. Am. Slime-Moulds, 52, in part (1899). *Lepidoderma Kurzii* Berk. in Herb. ; Mass. Mon., 255 (1892) ?

Pl. 25.—*a*. sporangia ; *b*. capillitium and spores ; *c*. spore (Philadelphia).

This species is closely allied to *P. citrinum*, differing in the more slender form, the smaller sporangia, the delicate flexuose capillitium threads and the absence of a columella.

Hab. On dead wood. Moldavia, Portugal, Ceylon, Borneo, Japan, North and South America, West Indies.

12. **P. columbinum** Sturgis in Mycologia, viii. 200 (1916) (*columba* a dove). Plasmodium light grey. Total height 1 to

2 mm. Sporangia stalked, scattered or loosely clustered, globose or somewhat flattened below, 0·5 mm. diam., erect or nodding, spotted with pure white, grey or bronze colour and iridescent between the spots, often dehiscing in petal-like lobes ; sporangium-wall membranous, with numerous well-defined rounded clusters of closely compacted lime-granules. Stalk erect or flexuose, subulate, furrowed, 0·5 to 1·5 mm. long, 0·05 to 0·13 mm. thick at the base ; white and densely charged with lime, often in the form of granules or crystalline nodules, brown or black below from the presence of refuse matter. Columella none ; a pseudo-columella usually present forming a calcareous ball 0·1 mm. diam. near the apex of the stalk. Capillitium abundant, of extremely delicate branching and anastomosing threads without expansions at the axils, somewhat persistent, and of a pale bluish colour after the dispersion of the spores ; lime-knots white, few, small, fusiform, except in the central globular cluster, or uniformly distributed and without a central globule. Spores violet-brown, almost smooth, 7 to 9 μ diam.—*P. Wingatense* Macbr. N. Am. Slime-Moulds, ed. 2, 72 (1922). *Tilmadoche columbina* Rost. Mon., App. 13 (1876). *T. compacta* Wing. in Proc. Acad. Nat. Sc. Phil. (1889), 48 ; Mass. Mon., 332. *Lepidoderma stellatum* Mass. l.c., 252 (1892). *Didymium Barteri* Mass. l.c., 231. *Physarum compactum* Lister Mycetozoa, ed. 2, 52 (1911).

Pl. 26.—*a*. sporangia ; *b*. apex of stalk and capillitium, with fragment of sporangium-wall, showing sharply defined clusters of lime-granules ; *c*. capillitium and spores ; *d*. spore (Dominica).

In the earlier editions of this work the present species appears under the name *Physarum compactum* (Wing.) Lister. Although it seemed probable that *Tilmadoche columbina* Rost. was the same species, the remains of Berkeley's type from Venezuela in the Kew Herbarium, marked by the unpublished name *Didymium columbinum* Berk. & Curt. was too scanty to afford complete proof ; Dr. W. C. Sturgis having examined the portion of the same gathering in Curtis's Herbarium finds there the white stalks with chalky fracture, the delicate persistent capillitium with small rounded lime-knots characteristic of *P. compactum* ; he points out that the latter name must by the rule of priority be superseded by that of *Physarum columbinum*. In a fine specimen of the present species from Dominica (K. 567, type of *Lepidoderma stellatum* Mass.) the stalks are pure white with a chalky section to the base. *D. Barteri* Mass. (type in Herb. Massee) collected by Barter on Prince's Island, Niger Expedition in 1881, is clearly *P. columbinum* ; the specimen is quoted under *P. globuliferum* by Rostafinski (Mon., App. 5).

Hab. On dead wood.—Nigeria, Cape Province, Uganda, Ceylon, Malay Peninsula, Java, Borneo, North and South America, West Indies.

13. **P. mutabile** Lister Mycetozoa, ed. 2, 53 (1911) (variable). Plasmodium watery-grey. Sporangia erect, cylindrical, ovoid, or subglobose, 0·3 to 0·6 mm. diam., white, rugulose, stalked or sessile, or forming elongated branched plasmodiocarps ; sporangium-wall with rather evenly dis-

tributed deposits of lime-granules. Stalks stout or slender, 0·1 to 0·4 mm. high, ochraceous-yellow rarely orange-brown, usually enclosing white lime-granules but sometimes almost free from lime, often connected at the base by a yellowish or white hypothallus. Capillitium a persistent network of firm hyaline threads with expansions at the axils ; lime-knots white, varying in size and shape, either scattered through the capillitium, or in the stalked forms for the most part confluent in the centre of the sporangium and forming a clavate columella, which is either free or continuous with the apex of the stalk. Spores purple-brown, spinulose, 7 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 99. *Crateriachea mutabilis* Rost. Mon., 126 (1875) ; Mass. Mon., 344. *Physarum cinereum* Lister Mycetozoa (1894), in part. *P. Crateriachea* Lister in Journ. Bot., xxxiii. 324 (1895).

Pl. 44.—*a*. sporangia (from near Luton, Beds.) ; *b*. capillitium and spores ; *c*. spore.

A widely distributed and variable species. In this country it is sometimes found in great abundance on heaps of old straw, dead leaves or herbaceous stems ; stalked, sessile or plasmodiocarp forms occur side by side, while the lime-knots show every stage from being quite free to uniting to form a well-defined clavate or cylindrical columella ; the calcareous matter is often partly in the form of crystalline discs. The specimens distributed by Cesati as '*Didymium neapolitanum*', from Naples (B.M. 573), and also those marked *Didymium squamulosum* var. *herbarum* by Rabenhorst & Winter, No. 2969, from Pavia (B.M. 542), are the sessile subglobose form of the present species ; in both sets the lime-knots are partly free, partly united to form an irregular pseudo-columella.

Hab. On dead leaves, herbaceous stems and old straw, in summer and autumn, not uncommon in the south of England : recorded from Scotland, France, from Holstein, Germany, Sweden, Moldavia, Italy, Cameroons, South Africa, and Ceylon.

14. **P. roseum** Berk. & Br. in Journ. Linn. Soc., xiv. 84 (1873) (*rosa* rose). Plasmodium maroon-red. Total height 1 mm. Sporangia globose, 0·4 mm. diam., stalked, gregarious, nearly smooth, bright rose-coloured ; sporangium-wall membranous, with innate clusters of purple-red lime-granules. Stalk erect, slender, subulate, reddish-brown, translucent, longitudinally wrinkled. Columella none. Capillitium a loose network of slender pale lilac threads, with rather few large irregularly branching purple-red lime-knots. Spores reddish-lilac or reddish-brown, minutely spinulose, 7 to 10 μ diam.—Rost. Mon., App. 10 ; Mass. Mon., 294 ; Petch in Ann. Perad., iv. 331 ; Macbr. N. Am. Slime-Moulds, ed. 2, 100.

Pl. 27.—*a*. sporangia (Ceylon) ; *b*. capillitium and spores ; *c*. spore.

This species differs from *P. pulcherrimum* in the large lime-knots and the translucent stalks.

Hab. On dead wood and leaves.—Nigeria, South Africa, Uganda, Ceylon, Malaya, Java, Borneo, New Caledonia, Japan.

15. **P. Newtoni** Macbride in Bull. Nat. Hist. Iowa, ii. 390

(1893) (Prof. G. W. Newton, the discoverer of the species). Plasmodium ? Sporangia shortly stalked or sessile, globose, or flattened and umbilicate above, about 0·5 mm. diam., violet-purple, smooth, opaque ; sporangium-wall membranous above, with innate deposits of purple lime-granules, rugose and thickened towards the base, where it is deep purple and densely charged with calcareous deposits. Stalk strongly wrinkled, purple-brown. Columella none. Capillitium consisting of delicate branching violet threads, with numerous large angular purple lime-knots. Spores dark purple-brown, rough with irregularly scattered warts, 8–10 μ diam.—N. Am. Slime-Moulds, ed. 2, 73.

Pl. 28.—*a*. stalked and sessile sporangia ; *b*. capillitium and spores ; *c*. spore (Colorado).

The shape of the sporangia and the dark rough spores appear to be the only points which distinguish this rare species from *Craterium paraguayense* (Spegaz.) Lister, with which it agrees in colour, in the character of the capillitium, and in the structure of the sporangium-wall.

Hab. On sticks at an altitude of several thousand feet, Pike's Peak, Colorado.

16. **P. psittacinum** Ditm. in Sturm Deutsch. Fl. Pilze, iv. 125, tab. 62 (1817) (*psittacus*, parrot). Plasmodium orange. Total height 1 mm. Sporangia stalked, globose or somewhat depressed, gregarious, 0·5 to 0·8 mm. diam., purplish-blue mottled with red, iridescent ; sporangium-wall hyaline, membranous, sprinkled with orange spots of thicker more or less granular substance. Stalk erect or curved, furrowed, vermilion or orange-red, intense clear orange in mountings in glycerine, without deposits of lime, rising from a well-developed hypothallus of the same colour. Columella none. Capillitium a close network of flat arching colourless or yellowish threads, broad at the axils ; lime-knots numerous, varying in size, sharply angular, often branching, sometimes confluent in the centre of the sporangium, bright orange, obscurely granular or translucent. Spores greyish-violet, minutely warted, the warts often grouped in clusters, 7 to 8 μ diam.—Fries Syst. Myc., iii. 134 ; Rost. Mon., 104, figs. 75, 76 ; Mass. Mon., 274 ; Macbr. N. Am. Slime-Moulds, ed. 2, 74. *P. Carlylei* Mass. l.c., 293 (1892). *Didymium fulvipes* Fries Symb. Gast., 24 (1817) ?

Var. **fulvum** Lister in Journ. Bot., xliv. 228 (1906) (tawny). —Stalk and base of sporangium-wall fulvous yellow instead of vermilion.

Pl. 29.—*a*. sporangia (Lyme Regis) ; *b*. sporangia of var. *fulvum* (Ceylon) ; *c*. capillitium and spores, with fragment of sporangium-wall showing crystalline discs ; *d*. spore.

In glycerine mountings of this species flattened disc-shaped crystalline bodies with radiating structure are usually seen imbedded in the sporangium-wall, as in *P. virescens* and *P. dictyospermum*. The type specimen of *P. Carlylei* Mass. from Carlisle (K. 68) is normal *P. psittacinum*.

Hab. On dead wood, not unfrequent in summer in England ; recorded

also from Wales, E. Ireland, France, Sweden, Germany, Switzerland, Austria, Roumania, North America : var. *fulvum* Ceylon, Japan.

17. **P. dictyospermum** Lister in Journ. Bot., xliii. 112 (1905) (δίκτυον net, σπέρμα spore). Plasmodium? Sporangia subglobose, shortly stalked, erect, scattered, 0·5 to 0·6 mm. diam., dull orange, dark chestnut or olive-brown, glossy ; sporangium-wall membranous, rather firm, orange. Stalk 0·1 to 0·7 mm. high, slender, black, enclosing dark refuse matter, or sometimes pale yellow above from superficial deposits of lime-granules. Columella black, conical or clavate, short or two-thirds the height of the sporangium. Capillitium an abundant persistent network of slender colourless threads, with small fusiform orange-red lime-knots. Spores pale purplish-grey, 10 to 11 μ diam., closely reticulated with narrow dark bands ; these form a net with five or six meshes across one side of the spore ; on the other side the meshes are more faint and irregular ; sometimes the spores are marked with short curved lines, not forming a net.—Torrend Fl. Myx., 195. Macbr. N. Am. Slime-Moulds, ed. 2, 100.

Pl. 30.—*a*. sporangia (Stewart Island) ; *b*. capillitium and spores, with fragment of sporangium-wall showing the crystalline discs ; *c*. two spores showing respectively the strong and delicate reticulation of the two sides.

This species was first found in February 1904 by Miss A. Hibbert-Ware in dense bush on Stewart Island, New Zealand. It is distinguished from the other known species of *Physarum* by the strongly reticulated spores. Its nearest ally is, perhaps, *P. psittacinum*, which it resembles in having orange-red lime-knots, and in the sporangium-wall being studded with orange crystalline discs.

Hab. On dead wood.—Jura Mountains, New South Wales, New Zealand, Chili.

18. **P. viride** Pers. in Usteri Ann. Bot., xv. 6 (1795) (green). Plasmodium yellow. Total height about 1 mm. Sporangia stalked, subglobose or lenticular, nodding, 0·3 to 0·5 mm. diam., yellow ; sporangium-wall dehiscing in fragments, membranous, with innate clusters of yellow lime-granules. Stalk subulate, slender, striate, grey or straw-coloured, sometimes yellow at the apex shading to red below, usually brown in the lower half from enclosed refuse matter, rarely with deposits of lime. Columella none. Capillitium a loose irregular network of slender acutely branching hyaline threads, with fusiform orange lime-knots. Spores brownish-lilac, almost smooth, 7 to 10 μ diam.—Ditm. in Sturm Deutsch. Fl., Pilze, 49, t. 24 ; Macbr. N. Am. Slime-Moulds, ed. 2, 98. *Sphaerocarpus viridis* Bull. Champ., t. 407, fig. 1 (1791). *Stemonitis viridis* Gmel. Syst. Nat., ii. 1469 (1791). *Physarum aureum* Pers. in Roemer N. Mag. Bot., 88 (1794). *P. nutans* β. *viride*, γ. *aureum* Fries Syst. Myc., iii. 129 (1829). *Trichia viridis* DC. Fl. Fr., ii. 253 (1805). *Tilmadoche mutabilis* Rost. Mon., 129 (1875) ; Mass. Mon., 329. *T. viridis* Sacc. in Michelia,

ii. 263 (1880). *Chondrioderma exiguum* Racib. in Hedw., xxviii. 119 (1889).

Var. **aurantium** Lister Mycetozoa, 47 (1894). (Mid. L. orange). Sporangia orange, lime-knots orange, fusiform. *Sphaerocarpus aurantius* Bull. l.c., tab. 484, fig. 2. *Stemonitis aurantia* Gmel. l.c., 1469. *Physarum aurantium* Pers. Syn. Fung., 173 (1801). *P. nutans* γ. *coccineum* Fr. l.c. *P. striatum* c. *aurantiacum* Fr. l.c., 131. *Trichia aurantia* DC. l.c.

Var. **incanum** Lister l.c. (hoary). Sporangia grey or pale-yellowish grey, lime-knots pale yellow, fusiform. *Sphaerocarpus luteus* Bull. l.c., t. 407, fig. 2 ? *Stemonitis bicolor* Gmel. l.c., 1469. *Physarum luteum* Pers. l.c. *Trichia lutea* DC. l.c.

Var. **Bethelii** Sturgis in Color. Coll. Publ., Sc. Ser. xii. 439 (1913) (Prof. E. Bethel, of Denver, Colorado). Sporangia subglobose, umbilicate beneath, pale yellow, or iridescent blue from absence of lime ; capillitium a dense network, with large irregular pale yellow lime-knots. *Physarum Bethelii* Macbr. in litt. and N. Am. Slime-Moulds, ed. 2, 94 (1922) ; Lister Mycetozoa, ed. 2, 57.

Var. **hinnuleum** G. Lister in Journ. Bot., lxii. 17 (1924) (from *hinnulus* a fawn). Sporangia and lime-knots fawn-coloured ; spores buff, containing deposits of lime.

Pl. 31.—*a*. sporangia (England) ; *b*. sporangia, var. *aurantium* (England) ; *c*. sporangia, var. *incanum* (England) ; *d*. capillitium and spores ; *e*. spore.
Pl. 200 var. *Bethelii*.—*a*. iridescent sporangia (Colorado, from type specimen) ; *b*. capillitium and spores ; *c*. spore ; *d*. sporangia with abundant lime (Cheyenne Mountain, Colorado).

In this abundant and variable species, the sporangium-wall is somewhat persistent when the lime is abundant ; when the lime is more scanty the wall soon breaks up in small fragments, remaining attached to the capillitium. The colour of the sporangia found on the same stump may differ from one year to another. The lime-knots are very variable both in size and colour ; pale yellow sporangia have often orange knots, and dark sporangia have light orange knots. The stalks vary in tint in all forms. The specimen from Chili (*leg.* Gay) in the Paris Museum, given by Rostafinski (Mon., App. 7) as a type of *Physarum Leveillei* var. *chrysopus*, is the orange form of *P. viride* ; the stalks are free from lime-deposits and the capillitium consists of slender threads with fusiform orange lime-knots. The var. *Bethelii*, first found by Prof. Bethel in Colorado in 1908, has been gathered repeatedly since by Dr. Sturgis in the same State, showing every stage between this robust form and typical *P. viride*, to which it bears the same relation as the var. *leucophaeum* does to *P. nutans* Pers. In some developments of var. *Bethelii* the bright yellow or sulphur-coloured sporangia are grouped in close clusters with confluent stalks.

Hab. On dead wood ; the typical form with var. *aurantium* and var. *incanum* is fairly common throughout the British Isles, Europe, North and South America, S. Africa, New S. Wales, and Japan ; in the tropics var. *aurantium* appears to be more abundant : var. *Bethelii* has been recorded from Moldavia and the State of Colorado : var. *hinnuleum* from the United Provinces, India.

19. **P. rigidum** G. Lister (from the rigid capillitium). Plasmodium yellow. Sporangia gregarious, stalked, lenticular,

often umbilicate above, yellow, dull orange, or iridescent from absence of lime-granules. Stalk slender, orange or yellow above, dark below from included refuse matter, 0·3 to 1·5 mm. high. Capillitium of sparingly branched threads or flattened tubes with long narrow orange lime-knots, or consisting almost entirely of slender rod-like tubes enclosing lime-granules. Spores rich violet-brown, minutely spinulose, 9 to 12 μ diam.—*P. viride* var. *rigidum* Lister Mycetozoa, ed. 2, 56 (1911).

Pl. 199.—*a*. sporangia (Japan); *b*. spores and capillitium with fragment of sporangium-wall; *c*. spore.

This species is distinguished from *P. viride*, of which it is given as a variety in the second edition of this work, by the simple rigid capillitium and the darker larger spores. Mr. A. R. Sanderson writes, 'It is by far the commonest form in tropical Malaya, immense colonies appearing with great regularity, frequently on *Schizophyllum commune* Fries,' and other fungi on which the plasmodium feeds with avidity (see his note 'On the parasitic Habits of the Plasmodium of *Physarum viride* var. *rigidum*,' Trans. Br. Myc. Soc., vii. 299 (1922)).

Hab. On dead wood, *Schizophyllum*, &c.—South Nigeria, Ceylon, Malay Peninsula, Japan, West Indies.

20. **P. polycephalum** Schwein. Syn. Fung. Car., p. 63, no. 382 (1822) (πολύς many, κεφαλή head). Plasmodium occurring in masses of decaying leaves or in rotten logs; at first colourless, as it emerges for fructification white, then yellow, spreading far over all adjacent objects (Macbride). Total height 1·5 to 2 mm. Sporangia stalked, much compressed, lenticular, undulate or lobed, confluent in clusters of 3 to 10, grey or yellow; sporangium-wall membranous, with scattered thin innate clusters of white or yellow lime-granules. Stalks subulate, slender, inclined or flexuose, usually fasciculate, 3 to 10 combined, yellow or tawny, translucent. Capillitium a loose network of slender threads with many flat expansions at the axils; lime-knots yellow, very variable in shape, size, and abundance. Spores violet-brown, minutely spinulose, 8 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 95. *Didymium polycephalum* Fries Syst. Myc., iii. 122 (1829). *D. polymorphum* Mont. in Ann. Sci. Nat., sér. 2, viii. 361 (1837). *D. gyrocephalum* Mont. l.c., 362. *D. luteogriseum* Berk. & Curt. in Grev., ii. 65 (1873). *Physarum polymorphum* Rost. Mon., 107 (1875); Mass. Mon., 283; Lister Mycetozoa, 48. *Tilmadoche gyrocephala* Rost. l.c., 131; Mass. l.c., 335.

Var. **obrusseum** Lister l.c. (ὄβρυζον pure gold). Sporangia free, not united in clusters.—*Didymium obrusseum* Berk. & Curt. in Journ. Linn. Soc., x. 348 (1869). *D. tenerrimum* Berk. & Curt. l.c.; Mass. l.c., 247. *Physarum obrusseum* Rost. Mon., App. 11 (1876).

Pl. 34.—*a*. yellow and grey sporangia (Philadelphia); *b*. capillitium and spores; *c*. spore.

The description given by Schweinitz of *Physarum polycephalum* is sufficiently good to leave no doubt as to its identity with the present species; this name therefore takes precedence over *Physarum polymorphum* (Mont.) Rost. The type of *Tilmadoche gyrocephala* (Mont.) Rost. from Brazil appears to have been lost, but from Rostafinski's excellent description it clearly must be assigned to the present species. The type of *Didymium obrusseum* Berk. & Curt. from Cuba (B.M. 440) has much compressed and undulated sporangia, similar to the free sporangia frequently met with in *P. polycephalum*. The colour of the sporangia varies from grey to yellow in the same gatherings. Dr. W. C. Sturgis, having examined the type of *Didymium luteogriseum* B. & C. gathered by Dr. Michener in Pennsylvania in 1851, in the Curtis herbarium, writes, 'The specimen named by Michener himself is in fine condition and is typical *Physarum polycephalum*. It is interesting to note, however, that most of the sporangia in this specimen are single and therefore are of the so-called variety "*obrusseum*"' (Sturgis in Mycologia, viii. 201 (1916)).

Hab. On dead wood and leaves.—France, Roumania, Borneo, Japan, United States, and West Indies: var. *obrusseum* United States and West Indies.

21. **P. flavicomum** Berk. in Hook. Journ. Bot., iv. 66 (1845) (*flavus* yellow, *coma* head of hair). Plasmodium yellowish-green. Total height 1·2 to 1·75 mm. Sporangia subglobose, or flattened beneath, stalked, nodding, 0·4 to 0·5 mm. diam., yellow, or grey with a yellow base or dark and iridescent from the absence of lime; sporangium-wall membranous, colourless above, yellowish below. Stalk slender, subulate, twisted, without deposits of lime, red, copper-coloured or pale brown. Capillitium a close network of hyaline threads with numerous yellow flat expansions at the axils, often persistent and retaining the form of the sporangium after the dispersion of the spores; lime-knots usually small, angular, yellow. Spores violet-brown, almost smooth, 7 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 93. *P. cupripes* Berk. & Rav. in Grev., ii. 65 (1873); Mass. Mon., 284. *P. Berkeleyi* Rost. Mon., 105 (1875); Lister Mycetozoa, 47; *Didymium flavicomum* Mass. l.c. 242 (1892).

Pl. 32.—*a*. sporangia (South Carolina); *b*. capillitium and spores.

The red-brown stalks usually free from all refuse matter, the denser net of the capillitium and more angular lime-knots distinguish this species from *P. viride*. It appears to be closely allied to both *P. galbeum* and *P. Maydis*; from the former it differs in having red-brown, not yellow stalks, and in the well-defined lime-knots; from the latter in the more slender habit, and in the persistent dense network of the capillitium. Specimens collected by Miss Duthie in Knysna Forest, Cape Province, and by Mr. W. N. Cheesman in New South Wales have spores measuring 10 to 11 μ, darker and more distinctly spinulose than usual.

Hab. On dead wood.—S. Africa, New South Wales, New Zealand, Ottawa, New Jersey, Ohio, South Carolina, Iowa.

22. **P. galbeum** Wing. in Macbr. N. Am. Slime-Moulds, 53 (1899) (yellow). Plasmodium ? Sporangia globose, scattered, stalked, usually erect, 0·4 to 0·5 mm. diam., bright

yellow, smooth ; sporangium-wall membranous, with rather dense clusters of yellow lime-granules. Stalk subulate or nearly cylindrical, 0·5 to 0·7 mm. high, translucent yellow, or yellow above and orange-red below. Capillitium a dense network of pale yellow threads or flattened strands ; lime-knots reduced to scanty deposits of lime in the expanded axils of the branches. Spores pale violet, almost smooth, 7 to 9 μ diam.

Pl. 199.—*d.* sporangia (Philadelphia) ; *e.* capillitium and spores ; *f.* spore.

This species is closely allied to *P. flavicomum* (q.v.), but the distinguishing characters appear to be constant.

Hab. On sticks and bramble-stems.—Norfolk, Surrey, Shropshire, Co. Down, Portugal, Pennsylvania, Iowa, Minnesota.

23. **P. Maydis** Torrend, Flore des Myxomycètes, 193 (1909) (*mays*, maize). Plasmodium yellow. Sporangia globose or obovoid, 0·4 to 0·6 mm. diam., stalked, scattered or gregarious, bright yellow or dull yellowish-buff, rugulose or scaly, often rufous below ; sporangium-wall yellow and membranous above, usually firm and redder at the base, containing abundant deposits of yellow lime-granules. Stalk firm, dark red-brown, translucent, or opaque below with refuse matter, 0·1 to 0·6 mm. high, stout or slender. Columella none. Capillitium a network of hyaline threads with expansions at the axils ; lime-knots numerous, branching, yellow, some occasionally uniting to form a pseudo-columella. Spores pale violet, nearly smooth, 9 to 10 μ diam. *P. oblatum* Macbr. N. Am. Slime-Moulds, ed. 2, 91 (1922), in part. *Craterium Maydis* Morg. in Journ. Cinc. Soc., xix. 15 (1896) ; Macbride l.c., ed. 1, 74.

Pl. 32.—*c.* sporangia (Ceylon) ; *d.* capillitium and spores ; *e.* spore.

The slender forms of this species somewhat resemble *P. flavicomum*, while the stouter forms with short stalks approach *P. auriscalpium* ; it presents, however, a distinct and constant centre. It was placed by the late A. P. Morgan in the genus *Craterium* on account of the thickened base of the sporangium-wall ; but this feature is not always present, and is one that may also be seen to a certain extent in both *P. flavicomum* and *P. auriscalpium*. We therefore follow Dr. Torrend in transferring *Craterium Maydis* to the genus *Physarum*, that it may stand between the two species with which it appears to form a connecting link. In the second edition of North American Slime-Moulds the name *P. oblatum* replaces that of *P. Maydis*, which becomes a synonym ; judging by Macbride's original illustration of *P. oblatum* (in Bull. Lab. Nat. Hist. Iowa, ii, Pl. xi, fig. 3 (1893)) the depressed sporangia figured seem to be more characteristic of *P. auriscalpium* (q.v.) and this was the view taken by Prof. Macbride in his first edition.

Hab. On dead wood, twigs, maize-stalks, &c. In hothouse, Dahlem, near Berlin ; Uganda, Ceylon, Java, Japan, the West Indies, and in the United States from Ohio to Iowa, Colorado and Washington.

24. **P. auriscalpium** Cooke in Ann. Lyc. Nat. Hist. New York, xi. 384 (1877) (ear-pick). Plasmodium orange-yellow.

Sporangia subglobose, 0·4 to 0·8 mm. diam., stalked or sessile, yellow-orange, pale yellow with an orange base, or rufous, rugulose or scaly, scattered or in small clusters ; sporangium-wall membranous, with clustered deposits of lime-granules. Stalk red-brown or blackish-brown, translucent, 0·1 to 0·4 mm. high. Capillitium consisting of large branching orange-yellow lime-knots, connected by short hyaline threads. Spores brownish-violet, minutely spinulose, 9 to 12 μ diam.—Lister in Journ. Bot., xxxvi. 115 ; Macbr. N. Am. Slime-Moulds, ed. 2, 90. *P. ornatum* Peck in Rep. N. Y. Mus., xxxi. 40 (1879) ? *P. oblatum* Macbr. Bull. Lab. Nat. Hist. Iowa, ii. 384 (1893). *P. sulphureum* Sturgis in Bot. Gaz., xviii. 197, Pl. xx, figs. 5–8 (1893). *Badhamia citrinella* Čel. Myx. Böhm. 76, t. iv, fig. 1 (1893) ; see Lister in Journ. Bot., xl. 211. *B. iowensis* Macbr. N. Am. Slime-Moulds, ed. 2, 36 (1922).

Pl. 33.—*a*. sporangia (South Carolina) ; *b*. capillitium and spores ; *c*. spore.

This species is closely allied on the one hand to *P. Maydis* and on the other to *P. rubiginosum* and *Badhamia decipiens*. *Badhamia iowensis* Macbr. has mottled grey and white sporangia with yellow-brown bases, short brown stalks and large angular yellow lime-knots with abundant connecting threads ; it appears to be a pale form of *P. auriscalpium* but almost merges into *P. Maydis*.

Hab. On dead wood, moss and twigs in summer.—Surrey, North Scotland, France, N. Germany, Switzerland, Bohemia, Portugal, Cape Province, Bengal, Malaya, United States, British Columbia.

25. **P. fulvum** Lister Mycetozoa, ed. 2, 60 (1911), *non* Fries (tawny). Plasmodium yellow. Sporangia globose or obovoid, 0·6 to 0·8 mm. diam., cream-white or pale fulvous, nearly smooth or rugulose, stalked or sessile, with a hypothallus of branching fulvous strands ; sporangium-wall of two closely connected layers enclosing abundant deposits of lime-granules. Stalk 0·1 to 0·5 mm. long, fulvous, weak and almost membranous, expanding below into strands of the hypothallus. Capillitium a dense persistent network of nearly colourless threads, with membranous expansions at the axils, and with scattered large angular often branched pale yellow or orange lime-knots. Spores dark purple-brown, spinulose, 10 to 12 μ diam.—*P. albescens* Macbr. N. Am. Slime-Moulds, ed. 2, 86 (1922). *Leocarpus fulvus* Macbr. l.c., ed. 1, 82 (1899).

Pl. 66.—*a*. sporangia (Colorado) ; *b*. capillitium and spores, with fragment of sporangium-wall ; *c*. spore.

The type of this species was gathered by Mr. E. Bethel ' on living willow ', growing in snow, 11,000 feet altitude, Loveland Pass, Colorado, in June, 1896. Dr. Sturgis has kindly allowed us to examine two other specimens, both of which were sent him by Mr. Wingate under the unpublished name ' *Physarum albescens* Phillips ', and which he agrees with us in thinking should be placed under *P. fulvum*. One specimen is marked ' Iowa, *leg.* Holway, *ex herb.* Rex ', the other ' Louisiana, *leg.* Langlois, *ex herb.* Ellis '. In both gatherings the pale cream-coloured sporangia are either subglobose and sessile, or form short plasmodiocarps, and show but little development

of hypothallus; they agree in other respects with the type of *P. fulvum*, except that the lime-knots in the Louisiana specimens are smaller and brighter yellow, and the Iowa specimen has rather paler and smoother spores, only 8 to 10 μ diam. Typical developments of *P. fulvum* have been obtained from several parts of Switzerland.

Hab. On leaves and twigs, usually at high altitudes.—Switzerland, and the States of Iowa, Colorado, Nevada, and Montana.

26. **P. penetrale** Rex in Proc. Ac. Nat. Sc. Phil. (1891), 389 (penetrating). Plasmodium orange-yellow. Sporangia stalked, erect, ellipsoid, or globose, 0·3 × 0·5 mm. diam., grey or pale greenish-yellow, smooth; sporangium-wall membranous, semi-transparent, with innate scattered clusters of pale yellow or white lime-granules, rupturing when mature into from two to four segments. Stalk erect or curved, 0·5 to 2 mm. high, slender, subulate, solid, translucent, dull red or golden red. Columella formed by a continuation of the stalk, penetrating the sporangium to about four-fifths its height, scarcely tapering to the wedge-shaped or expanded end, yellow. Capillitium a close network of slender hyaline threads with triangular expansions at the axils of the branches, arising from the whole length of the columella, persistent after the dispersion of the spores; lime-knots scattered, small, rounded, yellow. Spores pale brownish-violet, delicately spinulose, 5 to 6·5 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 70. *Cytidium penetrale* Morg. in Journ. Cinc. Soc., xix. 11 (1896).

Pl. 36.—*a*. sporangia (Ireland); *b*. sporangium after dispersal of spores showing the long columella, from a glycerine preparation; *c*. capillitium and spores; *d*. spores.

An immature specimen of this species occurs in the Strasburg collection named by Rostafinski '*Craterium leucocephalum, unreif*'. The solid translucent stalk, continued upwards as a columella, is a feature peculiar to *P. penetrale* in this genus.

Hab. On dead wood and moss.—Norfolk, Aberdeenshire, Ulster, France, Sweden, Germany, Switzerland, Roumania, Portugal, Cape Province, Java, New York, Pennsylvania, Ohio, Chili.

27. **P. citrinellum** Peck in Rep. N. Y. Mus. Nat. Hist., xxxi. 55 (1879) (citron yellow). Plasmodium greenish-white. Sporangia subglobose, 0·6 to 0·8 mm. diam., stalked, erect, gregarious, rugose, lemon-yellow or ochraceous, tinged with orange at the base; sporangium-wall of two layers, the outer cartilaginous, yellow, rugose, with dense included deposits of lime, easily separating from the colourless membranous inner layer. Stalk cylindrical, 0·2 to 0·4 mm. high, stout, plicate, orange-red, translucent. Capillitium a network of colourless hyaline threads, with many large, irregular, and branching white lime-knots. Spores purple-brown, rather strongly spinulose, 10 to 12 μ diam.—Mass. Mon., 278; Sturgis in Trans. Conn. Ac., x. 470–472. Macbride N. Am. Slime-Moulds, ed. 2, 85. *Didymium flavidum* Peck l.c., xxviii. 54

(1879). *Diderma citrinum* Peck, *non* Fries, l.c. xxii. 89 (1869). *Craterium citrinellum* Lister Mycetozoa, 74 (1894).

Pl. 68.—*a*. sporangia (Japan); *b*. sessile sporangia (New Hampshire); *c*. capillitium and spores, with fragment of sporangium-wall; *d*. spore.

In the first edition of the present work this species was placed in the genus *Craterium* in view of its affinity with *C. aureum*; as however there is no tendency in *P. citrinellum* to form on dehiscing a regular cup, it seems better to replace it in the genus *Physarum*. The slight tendency in *C. aureum* to form such a cup allows us to regard it as a *Craterium*, though at this point the distinction between the two genera becomes obviously artificial. Other differences from *C. aureum* are the more globose stouter-walled sporangia, and the larger rougher spores. Dr. Brandza found this species in some abundance maturing from greenish-white plasmodium in subalpine woods, near Neamt, Moldavia, in September 1919.

Hab. On dead wood and moss.—Moldavia, Japan, and in the eastern United States.

28. **P. carneum** G. Lister & Sturgis in Journ. Bot., xlviii. 73 (1910) (flesh-coloured). Plasmodium mustard yellow. Sporangia gregarious, stalked, subglobose, 0·4 to 0·6 mm. diam., rarely sessile or forming short plasmodiocarps, ochraceous-yellow with a reddish base, or dark grey from absence of lime, smooth or rugulose; sporangium-wall membranous, usually with evenly distributed lime-deposits, thicker at the base. Stalk cylindrical from a broader base, rugulose, flesh-coloured or dull red, translucent or opaque below with refuse matter, 0·2 to 0·5 mm. high. Capillitium a dense network of fragile angular branching white lime-knots with short connecting threads. Spores purplish-brown, spinulose, with a paler smoother area of dehiscence, 8 to 9 μ diam.—Howard in Journ. R. Micr. Soc., (1917) 265, Pl. xviii; Macbr. N. Am. Slime-Moulds, ed. 2, 85.

Pl. 204.—*a*, *b*. sporangia (Norfolk); *c*. sporangia, in one only the base remains (Colorado); *d*. capillitium and spores; *e*. spore with pale area of dehiscence.

The type of this species was found by Dr. W. C. Sturgis on dead wood, on Cheyenne Mountain, Colorado Springs, in the autumn of 1908, and also in subsequent years. Mr. H. J. Howard gathered it near Norwich, under bramble thickets, often in great profusion, in summer and autumn, in 1916, 1917, 1919 and 1922; the sporangia varied from yellow to purplish-grey, and the stalks were either pale red on a white discoid hypothallus or reddish-brown and rugged; in some cases the lime-knots were united to form a central pseudo-columella; the lime-granules within the knots are loosely compacted and rather large, 1·5 μ diam. A specimen from Dr. Torrend gathered near Lisbon, Dec. 1907, has the stalks pale with deposits of nearly white lime-granules in the walls.

Hab. On dead wood and twigs.—Norfolk, Portugal, Moldavia, Colorado.

29. **P. brunneolum** Mass. Mon., 280 (1892) (brown). Plasmodium yellow. Sporangia globose or subglobose and slightly depressed, stalked or sessile, 0·6 to 1·7 mm. diam., rarely forming plasmodiocarps, gregarious, yellow-brown, glossy; sporangium-wall dehiscing in revolute lobes or breaking up in fragments, consisting of two layers, the outer yellow-brown,

cartilaginous, the inner membranous, enclosing abundant deposits of white lime-granules. Stalk firm, cylindrical, red-brown or nearly black, without lime, 0·1 to 0·4 mm. high. Capillitium a network of colourless threads with numerous large irregular white lime-knots, some of which may coalesce to form a pseudo-columella. Spores purple-brown, spinulose, 8 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 58. *Diderma brunneolum* Phill. in Grev., v. 114 (1877).

Pl. 69.—*a*, *b*. sporangia from Portugal and California; *c*. capillitium and spores, with fragment of sporangium-wall; *d*. spore.

This species resembles *Craterium minutum* Leers in the texture and colour of the sporangium-wall, but differs strikingly in having no lid, as well as in the more delicate capillitium threads, and rougher spores. The type specimen, marked *Diderma brunneolum* in Phillips's herbarium, was gathered in California by Dr. Harkness in 1877, and consisted of sessile sporangia only. Since then this species has twice been collected in Portugal by Dr. C. Torrend, who found it on dead leaves of *Agave americana* and on fir bark, with both stalked, sessile and plasmodiocarp sporangia. Mr. W. N. Cheesman found *P. brunneolum* at Moruya, New South Wales, in August 1914, developing from yellow plasmodium and with orange-red sclerotium. A very robust form with pale tawny sporangia, from one to nearly two millimetres across, was collected in some abundance by Prof. Thaxter at Puntas Arenas, Chili, in March 1906 (see Sturgis in Mycologia, viii. 35 (1916)). The first British gathering was made by Miss M. Rea at Lisburne, Co. Down, in July 1917; a few of the sporangia are subglobose, the rest form more or less elongated plasmodiocarps, many of which have dried prematurely.

Hab. On dead wood.—Co. Down, Ireland; Portugal, New South Wales, California, Chili.

30. **P. nucleatum** Rex in Proc. Ac. Nat. Sc. Phil. (1891), 389 (a little nut). Plasmodium milk-white. Total height 1 to 2 mm. Sporangia globose, stalked, erect or inclined, 0·5 mm. diam., white, rarely iridescent from absence of lime, and rarely forming plasmodiocarps; sporangium-wall membranous, with scattered included clusters of white lime-granules. Stalk subulate or nearly cylindrical, 0·5 to 1·5 mm. long, wrinkled, pale buff, yellow or, rarely, reddish-yellow or streaked with red, translucent above, without deposits of lime, enclosing refuse matter at the base. Capillitium a close persistent network of very slender colourless threads with minute scattered rounded white lime-knots; in the centre of the capillitium is usually a shining white calcareous ball, 0·1 to 0·15 mm. diam., sometimes replaced by a cluster of irregular lime-knots. Spores pale brownish-lilac, minutely spinulose, 6 to 7 μ diam.—Macbride N. Am. Slime-Moulds, ed. 2, 72; *P. simile* Rost. Mon., App. 6 (1876) ?; Mass. Mon., 286 ?

Pl. 35.—*a*. sporangia (Philadelphia); *b*. capillitium showing the central calcareous ball, surrounded by small lime-knots; *c*. spore.

The type specimen of *P. simile* Rost. from Curtis, South Carolina (K.1255) has buff stalks without lime-deposits, and delicate persistent capillitium

with a central mass of lime; it is a poor development and in imperfect preservation; it should probably be referred to the present species, although Rostafinski's description of *P. simile* with the stalk continued into the sporangium as a cylindrical columella would apply better to *P. globuliferum* (see Rost. Mon., App. 6). The specimen from Roumania described by Dr. Brandza as 'No. 121. *Physarum* non dét.' (in Ann. Sc. de l'Univ. de Jassy, x. 192 (1916)) is an irregular development of the present species; many of the sporangia form long plasmodiocarps; the stalks are reddish-yellow, and are either short or absent.

Hab. On dead wood; occurring in summer in England.—North Devon, Cornwall, Roumania, South Africa, Japan, the United States, and throughout the tropics; recorded also from Germany and Switzerland in hothouses.

31. **P. straminipes** Lister in Journ. Bot., xxxvi. 163, t. 386, fig. 2 (1898) (*stramen* straw, *pes* foot). Plasmodium milk-white. Sporangia greyish-white, obovoid or wedge-shaped, 0·7 mm. diam., clustered or scattered on long or short stalks, two or more often borne on a single stalk, or sessile and subglobose or irregularly ellipsoid; sporangium-wall colourless or pale purple, membranous, rather firm, with dense included clusters of lime-granules. Stalks straw-coloured, translucent, often 2 mm. long, membranous or cartilaginous, flattened or filiform, free from refuse matter, often continued below into a strand-like hypothallus. Capillitium a persistent network of stout rigid hyaline threads with expansions at the axils, and numerous rounded white lime-knots, some of which often unite to form a pseudo-columella. Spores 10 to 11 μ diam., purple-brown, marked with broad patches of warts separated by smoother tracts.—Torrend Fl. Myx., 197.

Pl. 42.—*a*. sporangia (Lyme Regis); *b*. capillitium and spores; *c*. spore.

Allied to *P. compressum*, but distinguished by the long slender translucent stalks, the rigid capillitium, and the peculiar distribution of warts on the spores.

Hab. On dead leaves and straw. Recorded from most of the southern counties of England, from Norfolk, Yorkshire, Aberdeenshire, North Wales, North and East Ireland; from France, Germany, and Chili.

32. **P. pusillum** Lister Mycetozoa, ed. 2, 64 (1911) (small). Plasmodium watery-white. Total height 1 to 2 mm. Sporangia subglobose, rarely obovoid or lenticular, stalked, erect or somewhat inclined, scattered, 0·4 to 0·6 mm. diam., white with a reddish base, rugose; sporangium-wall membranous, colourless above, with dense clusters of included white granules, thickened and rufous at the base. Stalk subulate or cylindrical, furrowed, 0·5 to 1·5 mm. long, red-brown, usually free from refuse matter. Capillitium a network of colourless branching threads; often varying in the same development; lime-knots either small and few, or large branching and numerous, or approaching the type of *Badhamia*. Spores pale brownish-lilac, almost smooth or marked

with patches of minute warts, 8 to 11 μ diam.—*Didymium pusillum* Berk. & Curt. in Grev., ii. 53 (1873). *Physarum nodulosum* Cke. & Balf., Rav. N. Amer. Fungi, no. 479 (1881) (undescribed); Macbr. N. Am. Slime-Moulds, ed. 2, 76 (1922). *P. calidris* Lister in Journ. Bot., xxix. 258 (1891); Lister Mycetozoa, 52. *P. gravidum* Morg. in Journ. Cinc. Soc., Nat. Hist. xix. 24 (1896). *P. mucoroides* Schilberszky in Bot. Centralbl., lxvi. 84 (1896). *Badhamia nodulosa* Mass. in Journ. Myc., v. 186 (1889); Mass. Mon., 322. *Craterium nodulosum* Morg. l.c., 15.

Pl. 43.—*a*. sporangia (Bedfordshire); *b*. capillitium and spores of the same; *c*. sporangia of stouter form (Wanstead, Essex); *d*. capillitium and spore of the same; *e*. spore.

P. pusillum, in its various forms, shows amongst the species of *Physarum* with white lime-granules a striking resemblance to the group *P. flavicomum*, *P. Maydis* and *P. auriscalpium* amongst the species with yellow lime-granules; the short-stalked form of *P. pusillum* with *Badhamia*-like capillitium merges into *Badhamia panicea* as *P. auriscalpium* merges into *Badhamia decipiens*. The type specimen from South Carolina in the Kew Herbarium, K. 1492, consists of two specimens on two slips of wood marked '*Didymium pusillum*'. On one slip is the present species, adequately described by Berkeley under this name in Grev. l.c. On the other are a few sporangia of *D. nigripes* var. *xanthopus*; these exactly resemble the type of *D. proximum* Berk. (= *D. nigripes* Fr. var. *xanthopus*), also from South Carolina. Confusion has arisen owing to this inadvertent combination of two species, with the result that Rostafinski gives *D. pusillum* as a synonym for *D. proximum* (Rost. Mon., App. 23), only noticing the characters of the latter. Dr. Sturgis finds that the specimen in Curtis's herbarium marked *D. pusillum* consists of the present species of *Physarum* only (see Mycologia, viii. 203). The specimen from Broome's Herb. named *P. elephantinum* Berk. & Br. M.S., from Ceylon (B.M. 453), is a large form of the present species, with capillitium and spores similar to those in the English gatherings. *P. nodulosum* Cooke & Balf. (B.M. 858) from South Carolina is also *P. pusillum*, but has almost *Badhamia*-like capillitium.

Hab. On dead leaves, twigs, straw, &c., frequent from summer to winter in England, less common apparently in Scotland and Ireland; widely distributed in Europe, Africa, Asia, Australia, and North and South America.

33. **P. didermoides** Rost. Mon., 97, fig. 87 (1875) (δίς double, δέρμα skin). Plasmodium white. Total height 0·5 to 1·3 mm. Sporangia stalked, erect and ovoid, about 0·8 mm. high, 0·5 mm. broad, or sessile, ovoid or subglobose, crowded, white, or dark grey above from the falling away or discontinuance of the outer calcareous crust; sporangium-wall of three layers, the outer a dense deciduous deposit of white lime-granules, the middle layer a delicate colourless membrane with scattered lime-granules, closely combined with an inner purplish, areolated, thicker layer. Stalk variable in length and thickness, white, membranous, not containing refuse matter and rarely enclosing lime-granules, rising from a plicate white hypothallus. Capillitium consisting of numerous rounded white lime-knots connected by short hyaline threads,

which are purple at the attachments to the sporangium-wall. Spores very dark purple-brown, closely and minutely spinulose, 10 to 13 μ diam.—Mass. Mon., 291 ; Macbride N. Am. Slime-Moulds, ed. 2, 78. *Spumaria ? didermoides* Acharius in Pers. Syn. Fung., Addenda, xxix (1801). *Diderma oblongum* Schum. Enum. Pl. Saell., ii. 197 (1803). *Physarum conglobatum* Fr. Symb. Gast., 21 (1818) ? *P. atrum* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 258 (1832). *P. lividum β licheniforme* Rost. Mon., 95 (1875) ; Mass. l.c., 304 (in part). *P. cinereum* var. *ovoideum* Sacc. in Michelia, ii. 334 (1882) ; Mass. l.c., 299 ? *P. platense* Speg. in Ann. Mus. Nac. Buen. Aires, vi. 199 (1899) ? *Spumaria licheniformis* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 261 (1832). *Claustria didermoides* Fr. Summ. Veg. Scand., ii. 451 (1849). *Didymium congestum* Berk. & Br. in Ann. Mag. N. H., ser. 2, v. 365 (1850). *Badhamia ? pulcherrima* Speg. in Bull. Acad. Nac. Cienc. Cord., xi. 474 (1889) ?

Fig. 45.—*a*. sporangia (Flitwick, Beds.) ; *b*. capillitium and spores, with fragment of sporangium-wall ; *c*. spore.

Var. **lividum** Lister in Journ. Bot., xxxvi. 161 (1898) (lead-coloured) differs from the type in the grey sporangia being always sessile and having usually a single layer only to the sporangium-wall, in the lime-knots being more angular, and in the rougher purple-black spores being paler and smoother on one side.

Pl. 46.—*a*. sporangia (Flitwick, Beds.) ; *b*. capillitium and spores, with fragment of sporangium-wall ; *c*. spore.

P. cinereum var. *ovoideum* Sacc. on *Ailanthus glandulosa* from Lyon, *leg.* J. Therry (B.M. 432), is a short-stalked form of *P. didermoides*, with sporangia arising from a white membranous hypothallus. *P. lividum* var. *licheniforme* Rost., portions of the type of which from South Carolina are in the Strasburg and Kew collections, is a sessile form of *P. didermoides*. The var. *lividum* is a well-marked and constant form, occurring on dead herbaceous stalks and old straw ; it has been recorded from five English counties. A specimen gathered near Lisbon by Dr. C. Torrend on dead twigs appears to be intermediate between this variety and the typical form ; the sessile globose sporangia have firm but single walls, and the lime-knots are rather angular, while the spores are dark brown and traversed by a band almost free from warts. Certain gatherings from Cintra and Japan resemble typical *P. didermoides* in all respects except that the stalks are cylindrical and charged with white lime-granules throughout.

Hab. On dead wood, leaves, or old straw, appearing in England from summer to winter. Recorded from Bedfordshire, Surrey, Sussex, Hampshire, Somerset, Norfork, and Yorkshire ; from France, Germany, Sweden, Moldavia, Portugal ; from Nigeria, Zululand, Uganda, Ceylon, Java, New South Wales, Japan, the West Indies, and North and South America : the var. *lividum* has been recorded from Bedfordshire, Buckinghamshire, Sussex, Worcestershire, and Derbyshire.

34. **P. nutans** Pers. in Usteri Ann. Bot., xv. 6 (1795) (nodding). Plasmodium watery-white, or yellowish-grey. Total height 1 to 1·5 mm. Sporangia gregarious, stalked,

erect or nodding, subglobose or lenticular, more or less flattened or concave beneath, 0·4 to 0·7 mm. broad, white, greyish-white, or iridescent from absence of lime ; sporangium-wall membranous, with included minute white granules in more or less dense clusters. Stalk subulate, longitudinally wrinkled, grey, yellowish, olivaceous or black, translucent above, sometimes opaque and white from deposits of lime in the wall, the tube of the stalk containing refuse matter. Capillitium consisting of colourless slender threads, branching at an acute angle and anastomosing, with few flat expansions at the axils and few small white lime-knots. Spores clear brownish-violet, nearly smooth or minutely spinulose, 8 to 10 μ diam.—Fr. Syst. Myc., iii. 128 ; Macbr. N. Am. Slime-Moulds, ed. 2, 97. *Sphaerocarpus albus* Bull. Champ., 137, t. 407, fig. 3, t. 470, fig. 1, A to G (1791). *Stemonitis violacea* Roth Fl. Germ., i. 548 (1788) ? *S. alba* Gmel. Syst. Nat., 1469 (1791). *Physarum bulbiforme* Schum. Enum. Pl. Saell., ii. 200 (1803). *P. albo-punctatum* Schum. l.c., 200. *P. Didymium* Schum. l.c., 202 ? *P. marginatum* Schum. l.c. ? *P. Pini* Schum. l.c., 203. *P. solutum* Schum. l.c., 204 ? *P. furfuraceum* Schum. l.c. *P. globosum* Schum. l.c. ? *P. albipes* Link in Mag. Ges. Nat. Fr. Berl., iii. 27 (1809) ? *P. sulcatum* Link l.c. ? *P. connatum* Ditm. in Sturm. Deutsch. Fl., Pilze, iii, t. 41 (1817) ? *P. gracilentum* Fr. l.c., 133 (1829). *P. cernuum* Fr. l.c., 130. *Trichia nutans* Trentep. in Roth Catal. Bot., i. 227 (1797). *T. alata* Trent. l.c., 228 ? *T. hemispheria* Trent. l.c. ? *T. alba* DC. Fl. Fr., ii. 202 (1802) ? *T. cernua* Schum. l.c., 211. *Didymium marginatum* Fr. l.c., 115. *D. furfuraceum* Fr. l.c., 116. *Tilmadoche cernua* Fr. Summ. Veg. Scand., 454 (1849). *T. nutans* Rost. Mon., 127 (1875) ; Mass. Mon., 327. *T. Pini* Rost. l.c., 128. *T. gracilenta* Rost. l.c., 129 ; Mass. l.c., 330. *T. anomala* Mass. l.c., 333 (1892) ? *T. alba* Macbr. N. Am. Slime-Moulds, 58 (1899).

Var. **leucophaeum** Lister Mycetozoa, 51 (1894) (λευκός white, φαιός dusky). Sporangia erect, 0·5 to 1 mm. diam., stalked, sessile or forming plasmodiocarps ; stalks stouter ; columella none, or occasionally present in the form of an irregular or conical continuation of the stalk into the sporangium ; capillitium with larger and often branched lime-knots ; spores 9 to 11μ.—*Physarum leucophaeum* Fr. Symb. Gast., 24 (1818) ; Rost. l.c., 113, figs. 77, 78, 89 ; Mass. l.c., 288 ; Macbr. l.c., 75. *P. confluens* Link in Mag. Ges. Nat. Fr. Berl., vii. Diss. 2, 43 (1815) ? *P. hypnorum* Link l.c., 43 ? *P. connexum* Link l.c. ? *P. conglobatum* Ditm. l.c., 81, t. 40. *P. granulatum* Balf. in Grev., x. 115 (1882) ; Mass. l.c., 289. *P. imitans* Racib. in Rozpr. Mat.-Przyr. Acad. Krak., xii. 73 (1884). *P. Readeri* Mass. l.c., 282. *Sphaerocarpus albus* Bull. Champ., p. 137, t. 470 H to L (1791). *Trichia filamentosa*

Trentep. in Roth Catal. Bot., i. 227 (1797). *Diderma terrestre* Fr. ex Weinm. Hymeno-Gastero-Myc., 574 (1836). *Tilmadoche nephroidea* Cel. Myx. Böhm., 69 (1893).

Var. **robustum** Lister l.c. (robust). Sporangia erect, often forming plasmodiocarps ; stalks grey, or white from enclosed deposits of lime ; capillitium more rigid, with the central lime-knots often confluent to form a pseudo-columella.—*Physarum albipes* de Bary in Zeitschr. Wiss. Zool., x. 95 (1866) ?

Pl. 37.—*a.* sporangia (Essex) ; *b.* capillitium and spores ; *c.* spore ; *d. d*[1]. sporangia, intermediate between the typical form and var. *leucophaeum* (Essex) ; *e.* capillitium of *d*, with abundant lime-knots ; *f.* capillitium of *d*[1], with few small lime-knots.

Pl. 38.—*a.* sporangia of var. *leucophaeum* (Essex) ; *b.* capillitium and spores of the same ; *c.* robust sporangia, with much lime in the walls ; *d.* capillitium and spores of *c* ; *e.* spore.

An extremely variable and abundant species. The stalked and plasmodiocarp forms may develop from the same growth of plasmodium ; sporangia may be found with delicate capillitium and few minute lime-knots, associated with others from the same plasmodium with wide expansions at the angles of the threads and with large lime-knots ; some may have erect stalks enclosing much refuse, standing with others more weakly formed, containing little refuse matter and nodding from the weight of the sporangium. As in all the *Calcarineae* the amount of lime in the sporangium-wall is liable to great variation ; where the supply is abundant it gives firmness and persistence to the membrane ; where it is scanty the wall is fragile or evanescent, as in the form named by Rostafinski *Tilmadoche nutans*. In contrast with the latter is var. *robustum* ; but between these extreme forms all shades of difference may be found, making it difficult to define even distinct varieties. The specimen of *T. gracilenta* Rost. from Poland in the Strassburg collection is a minute form of *P. nutans* with small, nearly globose sporangia of a greyish-white or greyish-violet colour. The type of *Physarum Readeri* Mass., from Melbourne (K. 500), is the var. *leucophaeum*, with spores 8 to 9 μ diam. (not 15 to 16 μ). The type of *P. granulatum* Balf. fil. (K. 67) is the same variety with the lime on the sporangium-wall in the form of crystalline nodules, a not infrequent transformation in species of *Physaraceae*. *P. nutans* var. *ovicarpum* Meylan (Bull. Soc. Bot. Genève, sér. 2, vi. 87 (1914)), from the Jura Mountains, has both subglobose and slightly ovoid sporangia ; it is an unusual form rather than a variety.

Hab. On dead wood, rarely on leaves ; common in the British Isles and Europe, from summer to winter ; very widely distributed elsewhere : the var. *leucophaeum* is not so abundant in tropical as in temperate regions.

35. **P. javanicum** Racib. in Hedw., xxxvii. 53 (1898) (from Java). Plasmodium ? Sporangia scattered, stalked, orbicular, either flattened, convex or obconical below, concave or umbilicate above, 0·6 to 0·8 mm. diam., 0·25 mm. thick, greyish-white ; sporangium-wall membranous with evenly distributed or clustered lime-granules, fragile and fugacious, often dehiscing by spreading lobes. Stalk subulate, slender, flexuose, 1·5 to 1·8 mm. high, white or pale straw-coloured above, darker from included refuse matter below. Capillitium a lax network of slender threads with long fusiform and branching white lime-knots, or almost *Badhamia*-like and

consisting of a network of branching tubes filled with lime-granules and attached to the sporangium-walls by straight hyaline threads. Spores greyish-lilac, nearly smooth, 9 to 10 μ diam.—Penzig Myx. Buit., 30. *P. discoidale* Macbr. N. Am. Slime-Moulds, ed. 2, 74, Pl. xx, figs. 3, 3*a* (1922)? *Physarella javanica* Torr. Fl. Myx., 174 (1909).

Pl. 197.—*a*. sporangia (Java); *b*. capillitium, with fragment of sporangium-wall; *c*. spore.

This graceful species is said to be common around Buitenzorg and not unfrequent at Tjibodas in the Island of Java. It appears to be closely allied to *P. nutans*, but differs in the shape of the sporangia and the more rigid capillitium. It bears considerable resemblance to *Trichamphora pezizoidea* Jungh., but the stalks are pale straw-coloured instead of dark red.

Hab. On dead wood, twigs and grass.—Cape Province, Uganda, Java, Florida, and, if *P. discoidale* proves to be this species, occurring also in California.

36. **P. crateriforme** Petch in Ann. R. Gard. Perad., iv. 304 (1909) (*crater* cup, *forma* shape). Plasmodium dull ochraceous. Sporangia scattered or in groups, greyish-white, rarely pale brown, cylindrical, obovoid, spherical or reniform, sometimes depressed, stalked, with occasional plasmodiocarp forms; sporangium-wall membranous with clustered deposits of white lime-granules. Stalk conical, black, or black below and white above, opaque from included refuse matter, 0·1 to 0·7 mm. long. Columella variable in colour and shape, white, yellow-brown or black, cylindrical and reaching to the apex of the sporangium, or ending below it and then clavate or shortly conical, sometimes absent. Lime-knots white or pale brown, either united to form a massive columella giving off horizontal spike-like points which end in simple or forked hyaline threads attached to the sporangium-wall or in the spherical sporangia, branched and forming an almost *Badhamia*-like network with few connecting threads. Spores dull lilac, closely spinulose, 10–13 μ diam.—Petch l.c., 336.

Pl. 76.—*a*, *b*. sporangia of various shapes; some sporangia in *b*. have no columella (Ceylon); *c*. sporangium, with spores dispersed showing columella; *d*. apex of columella; *e*. capillitium from sporangium without columella; *f*. spore.

In this variable species a single development may show ovoid, globose and reniform sporangia; the columella may reach and expand into the upper sporangium-wall and the capillitium have scanty fusiform lime-knots, or the columella may be absent and the lime-knots abundant. When spherical sporangia appear alone they closely resemble *P. nutans* var. *leucophaeum*, but are distinguished by the laxer net of the capillitium, the more spike-like lime-knots, and the rather larger spores. *P. crateriforme* is also nearly allied to *Badhamia affinis* Rost.

Hab. On dead wood, herbaceous stalks or the bark of living trees.—Weybridge, Aberdeenshire, Dublin, Lisbon, South Nigeria, Ceylon, Japan, Antigua.

37. **P. compressum** Alb. & Schw. Consp. Fung., 97 (1805) (compressed). Plasmodium white. Total height 1 to 1·5 mm. Sporangia reniform or obovoid, compressed, erect, splitting

along the ridge, stalked, sessile or forming plasmodiocarps, scattered, clustered or confluent, white or grey, rugose or closely spotted with white; sporangium-wall membranous, colourless or purplish below, including dense clusters of white lime-granules. Stalk stout, furrowed, black from contained refuse matter, or brownish or white from deposits of lime in the wall. Capillitium a close network with numerous rounded white lime-knots, varying in shape and size, connected by rather short hyaline threads. Spores dark purplish-brown, more or less spinulose or echinulate, 9 to 14 μ diam.—Sacc. Syll., vii. 337; Macbr. N. Am. Slime-Moulds, ed. 2, 80. *P. griseum* Link in Mag. Ges. Nat. Fr., iii. 27 (1809)? *P. nephroideum* Rost. Mon., 93, figs. 80 to 82 (1875); Mass. Mon., 285. *P. candidum* Rost. l.c., 96. *P. affine* Rost. l.c., App. 5. *P. lividum* var. *conglobatum* Rost. l.c., 95, in part. *P. Phillipsii* Balf. fil. in Grev., x. 116 (1882). *P. glaucum* Mass. l.c., 284 (1892). *Didymium glaucum* Phill. in Grev., v. 114 (1876).

Pl. 39.—*a*. sporangia of various shapes developed from the same plasmodium (Hertfordshire); *b*. capillitium and spores; *c*. spore.

Pl. 40.—*a*. sporangia from the type of *P. Phillipsii*; *b*. capillitium and spores.

The sporangia of this abundant species may vary extremely in shape and general appearance, and in the size and roughness of the spores in different parts of one culture. The spines on the spore wall are usually evenly distributed, but are sometimes grouped in patches separated by narrow smoother tracts, which give the spore a faceted appearance, but this is never so marked as in *P. straminipes*. The granules in the sporangium-wall and lime-knots frequently coalesce into vitreous superficial scales or nodules; this feature is also met with in other species of *Physarum*. In preparations in water of highly calcareous sporangia part of the solid matter is found to dissolve, and, on drying, to crystallize on the slide in particles resembling those described. A culture from an extensive growth of plasmodium exhibited the forms α, β, and γ in the development of the sporangia.

α. Sporangia obovoid or reniform, laterally compressed, on short black or grey stalks, or sessile.

β. Sporangia obovoid or reniform, on white stalks 0·5 mm. long.

γ. Plasmodiocarps lobed and confluent, compressed or cylindrical.

The specimens named *P. nephroideum* Rost. (Strasb. Herb.) are the form α. The type of *P. candidum* Rost., from Juan Fernandez (K. 510), is the form β; in some of the sporangia the lime-knots coalesce to form a central mass; that of *P. Phillipsii* Balf. f., from Phillips's Herb., shows the forms α and γ; and that of *P. lividum* var. *conglobatum* Rost., from Ceylon, No. 55 (K. 1244), is the form α with short black stalks; that of *P. affine* Rost., from Cuba, No. 907 (K. 1350), is the form β with white stalks. The specimen named *Didymium botryoides* Berk. in Herb., from New Zealand (K. 1523)—named by Massee *D. radiatum* B. & C.—is the form α. *D. pruinosum* Berk. & Curt., from Cuba (K. 1515), given by Rostafinski as a synonym for *P. nephroideum* (Rost. Mon., App. 5), is the form α. The type of *Didymium glaucum* Phill. from California is form α; the sporangia are either on short black stalks or sessile.

Hab. On dead leaves, twigs, straw, &c.—Frequent in the British Isles throughout the year: widely distributed over Europe, Africa, Ceylon, Australia, East and West Indies, Japan, and America.

38. **P. connatum** Lister Mycetozoa, ed. 2, 71 (1911), *non* Ditm. (born together). Plasmodium white or grey. Sporangia stalked, scattered and free, or grouped in clusters of two or more, globose, turbinate or reniform, greyish-white, often darker at the base, 0·5 to 0·7 mm. diam.; sporangium-wall membranous with clustered deposits of lime-granules, rarely iridescent and almost free from lime. Stalk stout, furrowed, dark brown, yellowish or red-brown, buff or whitish, 0·1 to 0·7 mm. long, opaque with enclosed refuse matter. Capillitium a network of hyaline threads with numerous rounded or angular white lime-knots. Spores purple-brown, minutely and closely spinulose, 10 to 11 μ diam.—*Didymium connatum* Peck in Rep. N. Y. Mus., xxvi. 74 (1874); Sturgis in Trans. Conn. Acad., x. 477 (1900). *Physarum connexum* Morg. in Journ. Cinc. Soc., Nat. Hist. xix. 20 (1896). *P. compressum* var. d, Lister Mycetozoa, 54 (1894). *P. nephroideum* Rost., Macbr. N. Am. Slime-Moulds, 41 (1899), in part. *P. notabile* Macbr. l.c., ed. 2, 80 (1922). *P. tropicale* Macbr. l.c., 82. *P. polonicum* Skup. in Bull. Acad. Pol. Sc., 1924, 391, figs. 1–3.

Pl. 40.—*c.* sporangia (Iowa); *d.* capillitium and spores; *e.* spore.

Although very nearly allied to *P. compressum* the present species may be distinguished by the sporangia being more symmetrical and less compressed, and by the more angular lime-knots. *P. tropicale* Macbr. is a rather large form with little lime in the iridescent sporangium-walls and in the capillitium. Prof. Macbride rejects the name *P. connatum* on the ground that this combination stands as a synonym for another species and cannot therefore be used again; but many botanists consider that the rule 'once a synonym always a synonym' should not be too rigidly enforced, and in the present case the old descriptions of *P. connatum* given by Schumacher and by Ditmar respectively are too brief to be of any value. Peck's type of *Didymium connatum* is undoubtedly the present species.

Hab. On dead wood and bark.—Apparently rare in the Old World, and recorded only from Bedfordshire, Sweden, Poland, and Moldavia; in North America it is abundant in the United States, and has been obtained from both the eastern and western parts of Canada.

39. **P. melanospermum** Sturgis in Mycologia, ix. 323, Pl. 14, figs. 1–3 (1917) *non* Pers. (μέλας black, σπέρμα seed). Plasmodium? Sporangia stalked, gregarious, turbinate or discoid, usually umbilicate above, 0·4 to 0·7 mm. diam., greyish-white, rugulose; sporangium-wall membranous, with abundant deposits of white lime-granules, often brown and charged with refuse matter towards the base. Stalk stout, black, furrowed, 0·1 to 0·3 mm. long. Capillitium consisting of numerous white angular branching lime-knots connected by short hyaline threads. Spores dark brownish-purple, minutely and closely spinulose, with a pale nearly smooth germinal spot, 12·5 to 16 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 63 (1922); see his 'Corrigenda'.

Pl. 201.—*a*, *b*. discoid and turbinate sporangia; *c*. capillitium and spore; *d*. spore.

This well-marked species is distinguished from *Badhamia macrocarpa*, which it somewhat resembles, by the character of the capillitium and by the spores being marked with a pale germinal spot. It has been obtained abundantly in successive years in various parts of the State of Colorado, under shrubby thickets.

Hab. On dead twigs and leaves ; August.—Aurora and Colorado Springs, Colorado.

40. **P. reniforme** Lister Mycetozoa, ed. 2, 72 (1911) (*ren* kidney, *forma* shape). Plasmodium ? Sporangia scattered or clustered, stalked or almost sessile, reniform, obconic, bolster-shaped or lobed, usually compressed, 0·4 to 0·9 mm. diam., often confluent in clusters of from three to forty or more, greyish-white ; sporangium-wall membranous, with clustered deposits of lime-granules. Stalk wrinkled, variable in colour, either pale yellow, yellow-brown, or fuscous, usually rather slender and flexuose, 0·3 to 1 mm. long, enclosing refuse matter at the base. Capillitium with short hyaline threads connecting the numerous angular lime-knots which often unite to form a pseudo-columella, sometimes almost *Badhamia*-like. Spores 9 to 15 μ diam., brownish-purple, either faintly or strongly spinulose, often faceted with patches of spinules or warts.—*P. fasciculatum* Jungh. Fl. Crypt. Java, pl. 2, fig. 8, (1838) ? *Badhamia fasciculata* Rost. Mon., App. 2 (1876) ? *Tilmadoche reniformis* Mass. Mon., 336 (1892). *Didymium echinospora* Mass. l.c., 239. *Physarum nicaraguense* Macbr. in Bull. Nat. Hist. Iowa, ii. 382 (1893) ; Macbr. N. Am. Slime-Moulds, ed. 2, 83 ; Petch in Ann. Perad., iv. 334. *P. compressum* Alb. & Schw., Lister Mycetozoa, 54, in part (1894).

Pl. 41.—*a*. sporangia (Nicaragua) ; *b*. capillitium and spores ; *c*. spore.

This species, like the last, is nearly allied to *P. compressum*. It has now been obtained from many parts of the world retaining the following distinctive features :—the sporangia are smaller and often in much larger clusters than in *P. compressum*, the stalks are more slender, and the capillitium is often so densely charged with lime as to assume almost a *Badhamia* character. In the type from Ceylon (K. 1406) and in *Didymium echinospora* Mass., also from Ceylon (K. 1407), the sporangia are reniform or lobed, with slender brown stalks, and with spores 12 to 15 μ equally spinose all over. In extensive gatherings made by Mr. T. Petch at Peradeniya, Ceylon, where the species is fairly common, the sporangia are massed together in large clusters and solitary in the same colony. The type of *P. nicaraguense* Macbr. is very similar to the Ceylon gatherings, but the spores, which measure 9 to 11 μ, have the spinules evenly distributed instead of showing 'faceting'.

It seems probable that *Physarum fasciculatum* Jungh. is the present species. It is described as having globose white sporangia, dehiscing irregularly, fugacious above, persistent below ; stalks connected in clusters of three to six or more, erect, tough, dirty yellowish, attenuated upwards ; capillitium of tubes as in *Badhamia* ; spores violet, smooth, 11 to 14 μ. Specimens of *P. reniforme* gathered in Java by Prof. Penzig and recorded by him as *Badhamia fasciculata* (Myx. Buit., 18) agree with the above description, except that the sporangia are obconic, and the capillitium is

more that of a *Physarum* having the large branching lime-knots connected by short hyaline threads.

Hab. On dead wood and bark: common, apparently, throughout the tropics; recorded also from Japan, Pennsylvania, and New South Wales.

41. **P. cinereum** Pers. in Roemer N. Mag. Bot., i. 89 (1794) (ashy). Plasmodium watery-white or pale yellow. Sporangia sessile, subglobose, pulvinate, heaped, crowded or scattered, often forming simple or branched plasmodiocarps, 0·3 to 0·5 mm. broad, cinereous, more or less warted or veined with white; sporangium-wall membranous with included clusters of white lime-granules. Capillitium of branching hyaline threads, with numerous white lime-knots varying in size and shape; sometimes consisting of a *Badhamia*-like network with few hyaline threads. Spores brownish-lilac, almost smooth or spinulose, 7 to 10 μ diam.—Rost. Mon., 102, figs. 71, 72, 85; Mass. Mon., 288; Macbr. N. Am. Slime-Moulds, ed. 2, 59. *Lycoperdon cinereum* Batsch Elench. Fung., 155 (1783). *Trichia coerulea* Trentep. in Roth Catal. Bot., i. 229 (1797) ? *Physarum violaceum* Schum. Enum. Pl. Saell., ii. 199 (1803) ? *P. plumbeum* Fr. Syst. Myc., iii. 142 (1829); Morg. in Journ. Cinc. Soc. Nat. Hist., xix. 26 (1896). *P. capense* Rost. l.c., 113, fig. 93 (1875) ? *P. scrobiculatum* Mass. l.c., 300 (1892). *Didymium cinereum* Fr. l.c., 126. *D. scrobiculatum* Berk. in Hook. Lond. Journ. Bot., iv. 66 (1845). *D. oxalinum* Peck in Rep. N.Y. State Mus., xxxi. 41 (1879).

Pl. 47.—*a*. sporangia (Essex); *b*. capillitium and spores; *c*. spore.

This widely distributed species is often abundant on dead leaves, fir needles, or on heaps of old straw; it may occur in such quantity on turf as to have been described by a Canadian writer as disfiguring a lawn. It is connected by intermediate forms with *P. vernum* Somm. When the sporangia are clustered and nearly destitute of lime, *P. cinereum* is with difficulty distinguishable from *P. confertum*. *Physarum conglobatum* Ditm. (in Sturm Deutsch. Fl., Pilze, i. 40; Fr. Sys. Myc., iii. 142) has been placed by Rostafinski as a synonym for the present species; but the descriptions are too imperfect to be instructive. From Berkeley's description of *Didymium scrobiculatum*, Rostafinski was probably right in placing it under *P. cinereum*; hardly anything remains of the type from Swan River, Australia, in Berkeley's Herb. (K. 1518). Dr. Brandza finds in the beech woods of Moldavia a beautiful form which he has named var. *scintillans* (Ann. Sc. de l'Univ. de Jassy, xi. 122 (1921)), with clustered sporangia, iridescent blue from the absence of lime-deposits in their walls; as normal grey sporangia often occur in the same development it is apparently a form of *P. cinereum* rather than a true variety.

Hab. On dead leaves, straw, &c.—Common in the British Isles, in Europe, the United States and Japan; widely distributed throughout the tropics and the Southern Hemisphere.

42. **P. confertum** Macbr. N. Am. Slime-Moulds, ed. 2, 64 (1922) (crowded). Plasmodium yellow, or white. Sporangia subglobose, 0·2 to 0·4 mm. diam., sessile, confluent, clustered or heaped, dull violet-brown or dark grey, often veined with

white or sprinkled with minute white dots ; sporangium-wall membranous, pale purplish, with or without scanty deposits of lime. Capillitium a sparse network of hyaline threads with small angular or branching white lime-knots, often limeless. Spores brownish-violet, minutely warted, 10 to 12 μ diam.—*P. atrum* Morg. in Journ. Cinc. Soc., xix. 27 (1896) ; Macbr. l.c., ed. 1, 36 ; Lister Mycetozoa, ed. 2, 74. *P. reticulatum* Berl. in Sacc. Syll. Fung., vii. 350 (1888).

Pl. 64.—*a*. sporangia (New Brunswick) ; *b*. capillitium and spores with fragment of sporangium-wall ; *c*. spore.

This species has until recently been generally known as *Physarum atrum* Schw., but as the type of *P. atrum* proved to be a limeless form of *P. didermoides*, a new specific name was needed, and Prof. Macbride has supplied the appropriate one of *confertum* in reference to the clustered sporangia. Although closely resembling limeless forms of *P. cinereum* and *P. virescens*, this appears to be a constant species, distinguished by the much heaped sporangia and large spores. The late Prof. Farlow described it as being by far the commonest species in fir woods on Campobello Island, New Brunswick, in the summer of 1902 ; Prof. Macbride writes that it is not uncommon in the United States. Dr. Brandza finds it frequent on pine needles in subalpine woods in Moldavia. The Rev. W. Cran has also found it on pine needles in Aberdeenshire. These repeated gatherings confirm the stability of the species.

Hab. On dead wood, twigs and pine needles.—Aberdeenshire, Germany, Moldavia ; not uncommon in the United States.

43. **P. vernum** Somm. *in litt.* Fr. Syst. Myc., iii. 146 (1829) (vernal). Plasmodium white. Sporangia sessile, subglobose or forming short or elongated often crowded plasmodiocarps, greyish-white, 0·5 to 1 mm. diam., often several millimetres in length, rugulose ; sporangium-wall membranous usually densely charged with lime-granules. Capillitium consisting of short hyaline threads connecting numerous angular branching white lime-knots, that may unite in the centre to form a pseudo-columella. Spores purplish-brown, spinulose, 9 to 12 μ diam.—Lister in Journ. Bot., xxxv. 210 ; Macbr. N. Am. Slime-Moulds, ed. 2, 51. *Badhamia verna* Rost. Mon., 145 (1875), in part.

Var. **iridescens** G. Lister in Guide to Brit. Mycetozoa, ed. 4 (1919), 25 (iridescent). Sporangia shining dark brown from absence of lime in the walls ; capillitium with angular lime-knots enclosing large lime-granules, 1 to 2 μ diam. ; spores with a pale germinal area.

Pl. 48.—*a*. sporangia (Arolla, Switzerland) ; *b*. capillitium and spores ; *c*. spore.

This species differs from *P. cinereum* to which it is very closely allied in the darker and usually larger spores. A slender form is abundant in this country on heaps of dead leaves and old straw. The typical robust form, rich in calcareous deposits, and often forming long plasmodiocarps, is one of the commonest species in the Swiss Alps in spring when it occurs associated with *Diderma niveum* and *Lepidoderma Carestianum* on dead twigs, leaves and grass close to the edge of melting snow. The var. *iridescens* has pur-

plish sporangium-walls and unusually large granules in the lime-knots; it appears almost every autumn on holly leaves in Epping Forest; if it were not for the darker brown spores, this form would seem to be more nearly allied to *P. cinereum*.

Hab. On dead leaves, twigs, straw, &c.—Common in most of the southern counties of England; recorded also from Worcestershire, Norfolk, Yorkshire, North Wales, Scotland, France, Norway, Austria, Portugal, the Cape, Natal, S. Australia, Cuba: var. *iridescens* has been recorded from Cornwall, Devon, Dorset, Bedfordshire, Hertfordshire, Essex, Norfolk, Nottinghamshire, and from North Germany.

44. **P. ovisporum** G. Lister in Journ. Bot., lix. 91 (1921), Pl. 558, figs. 1, 1*a*, 1*b* (*ovum* egg, σπορά seed). Plasmodium white. Sporangia scattered, sessile, white, pulvinate or forming straight, curved or irregular plasmodiocarps, 0·5 to 0·8 mm. diam.; sporangium-wall minutely roughened with deposits of lime-granules, often with smoother areas where the lime-deposits are scanty. Capillitium consisting of numerous white rounded lime-knots, varying much in size, connected by short hyaline threads. Spores rich purple-brown, either globose, 9 to 11 μ diam., or oval, 10 × 12 to 13 μ, minutely warted, often marked with a pale smooth line of dehiscence.

Pl. 202.—*a*. sporangia; *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

This species has been met with in the neighbourhood of Lyme Regis for the last thirty years; it is closely allied to both *P. vernum* and *P. compressum*; from the former it differs in the minutely granular surface of the sporangia and the neat rounded lime-knots, and from *P. compressum* in the smoother sporangia being always sessile and not compressed. When the spores are oval and marked with a pale line of dehiscence they are unlike those of any other species in the genus.

Hab. On dead leaves in late autumn and winter.—Recorded from Devon, Dorset, Somerset, and Essex.

45. **P. sessile** Brandza in Ann. Sc. de l'Univ. Jassy, xi. 116 (1921) (sitting). Plasmodium greenish or greyish-white, or orange. Sporangia sessile, globose, or forming simple or branched plasmodiocarps, smooth or rugulose, varying from white and pale yellow to orange, 0·4 to 0·5 mm. diam.; sporangium-wall membranous with abundant deposits of lime. Capillitium consisting of numerous white or pale yellow rounded and angular lime-knots with short connecting threads. Spores pale brownish-lilac, 7 to 10 μ diam., almost smooth.—*P. variabile* var. *sessile* Lister in Journ. Bot., xxxvi. 114 (1898); Petch in Ann. Perad., iv. 329.

Pl. 22.—*a*. sporangia (Philadelphia); *b*. sporangia (Antigua); *c*. capillitium and spores; *d*. spore.

This was formerly regarded as a plasmodiocarp form of *P. variabile* Rex (a species now proved to be a form of *P. sulphureum* Alb. & Schw.), but numerous gatherings from many parts of the world justify its specific distinction. Dr. Brandza finds it very abundant and occurring in vast colonies in early summer amongst dead leaves in the wooded hills and mountains of Moldavia; Mr. Minakata also finds it in abundance on dead bamboo leaves in Japan. The specimen in the British Museum from Aiken,

South Carolina, named in Ravenel's collection *Cienkowskia reticulata* (B.M. 991), is a rich orange form of *P. sessile*.

Hab. On dead leaves, sticks, &c.—Switzerland, Moldavia, Ceylon, Japan, East and West Canada, South Carolina, Antigua, and Venezuela.

46. **P. gyrosum** Rost. Mon., 111 (1875), in part (γῦρος circle). Plasmodium creamy white or dull yellowish-white. Sporangia stalked or sessile, much compressed, clustered, forming rosettes, or labyrinthine plasmodiocarps one to many millimetres diam., pinkish-grey, usually seated on a pink or dull red hypothallus; sporangium-wall membranous with clustered deposits of white or reddish lime-granules. Stalk slender, dull red, formed by a strand of the hypothallus. Capillitium a scanty network of hyaline threads with numerous large white transversely placed fusiform or irregular lime-knots. Spores pale brownish-violet, minutely spinulose, 6 to 10 μ diam.—Mass. Mon., 307 (in part); Lister in Journ. Bot., xl. 210, t. 438, fig. 2; Petch in Ann. Perad., iv. 339; Macbr. N. Am. Slime-Moulds, ed. 2, 95. *P. cerebrinum* Mass. l.c., 306 (1892). *Lignidium reniforme* Fr. Sym. Gast., 10 (1817)? *Fuligo septica* Gmel., Lister Mycetozoa (1894), in part. *F. gyrosa* Jahn in Ber. Deutsch. Bot. Gesell., xx. 272 (1902).

Pl. 52.—*a*. rosette-like cluster of sporangia (Ceylon); *b*. capillitium and spores; *c*. spore.

This species is on the borderland between the genera *Physarum* and *Fuligo*; the sporangia are either free and simple, or form a net which may be regarded either as a much branched plasmodiocarp or as a small aethalium. Rostafinski's type from Berlin, gathered by Braun (Strasburg Collection), shows pink rosette-like clusters of sporangia with most of the spores dispersed. The type of *P. cerebrinum* Massee, which appeared in a pot of palm seeds in the palm house, Kew Gardens (K. 195), is the present species. Dr. Jahn has found the sporangia repeatedly on earth and seedling plants in the forcing-houses of the Botanic Gardens, Berlin. Mr. T. Petch, writing from Ceylon, says, 'I found one evening a creamy-white plasmodium emerging in small pillars about 1 cm. high from the sides of holes 6 inches deep on land prepared for planting cocoa. Next morning all the pillars had collapsed into small rosettes on a central pinkish hypothallus; with the exception of one piece on a blade of grass the sporangia were all formed on stone, pieces of glass and earth, and seemed to be in a continuous sheet, but they separated easily from each other.' Mr. K. Minakata, writing from Tanabe, Japan, describes a large growth of plasmodium which was milk-white when it first emerged from the ground and spread over surrounding objects; it then turned to 'clear Amazonite blue', a colour it retained for some hours before maturing to form sporangia; these were either normal, or united into flat almost continuous dark grey masses surrounded by sheets of dull red-brown hypothallus. Where the blue plasmodium was injured it changed to a blood-red colour on drying. *P. gyrosum* appeared in March 1919 on soil in a propagating house in the Royal Botanic Gardens, Edinburgh; from a culture of the spores on bread Dr. M. Wilson obtained the 'dirty-yellow white' plasmodium. This species also developed in a cucumber house near Norwich in February 1922. *Didymium daedalium* Berk. & Br. (in Ann. Mag. Nat. Hist., ser. 2, v. 366 (1850)) is probably the present species; the description is as follows:—

'Sporangia connate, labyrinthine-sinuous, pale brick-red, of the same colour as the short connate stalks, sprinkled with white meal; flocci white; spores purple-black, smooth, globose. *Hab.* In great abundance in a cucumber frame.—Milton, Norths. Spreading far and wide in little globose masses; stems reddish-brown, inclining to orange, connate, as if composed of little flat bran-like membranes, sporangia having a greyish tinge from the contained spores, which are purple-black; variegated with the white flocci, which are frequently forked, and vary greatly in width, being in parts flat, broad, and membranous.' In the absence of the type this reference remains uncertain. It is unfortunate that Rostafinski and Massee after him included *Fuligo muscorum* (q.v.) among the synonyms of the present species.

Hab. On earth, leaves, &c.—In glass-houses in Scotland, England, Denmark, France, Germany, and Switzerland; recorded from Germany, South Nigeria, Madagascar, Ceylon, Victoria (Australia), Japan, New York State, Brazil.

47. **P. Famintzini** Rost. Mon., 107 (1875) (A. S. Famintzin, a Russian botanist, b. 1833). Plasmodium orange. Sporangia subglobose or reniform, sessile, about 0·4 mm. diam., brownish-orange or chestnut brown, rugulose, clustered or heaped, with a colourless or yellow membranous hypothallus; sporangium-wall membranous or somewhat cartilaginous, with abundant clustered deposits of brownish-yellow lime-granules. Capillitium an elastic network of hyaline threads with large white angular or branching lime-knots sometimes forming a pseudo-columella. Spores purple-brown, spinulose, 10 to 12 μ diam.—R. E. Fries in Svensk Bot. Tidskr., vi. 740 (1912). *P. Gulielmae* Penzig Myx. Buit., 34 (1898); Lister Mycetozoa, ed. 2, 76; Torrend Fl. Myx., 182.

Pl. 63.—*a*, sporangia (Sweden); *b*, capillitium and spores, with fragment of sporangium-wall; *c*, spore.

The clustered brown sporangia form large colonies; when perfectly developed the sporangium-walls break and the elastic capillitium expands to form a column of twice its original length; specimens from Sweden and Switzerland illustrate this well, and correspond with Rostafinski's description of the type from Poland.

Hab. On twigs, herbaceous stems, &c.—Sweden, Germany, Switzerland, Poland, Java.

48. **P. echinosporum** Lister in Journ. Bot., xxxvii. 147, t. 398, fig. 1, *a*, *b*, *c* (1899) (ἐχῖνος hedgehog, σπορά seed). Plasmodium ? Sporangia scattered, forming chalk-white usually curved plasmodiocarps, strongly compressed laterally, dehiscing along the thin upper ridge; sporangium-wall of two layers, the outer smooth, eggshell-like, charged with minute lime-granules, separating from the inner membranous iridescent pale purplish layer. Capillitium consisting of numerous smooth white lime-knots, irregular in shape and size, connected by short hyaline threads. Spores purple, 8 μ diam., marked with strong ridges and spines.—Torrend Fl. Myx., 178.

Pl. 53.—*a*, sporangia (Antigua); *b*, capillitium and spores; *c*, spore.

Hab. On dead leaves.—Antigua.

49. **P. sinuosum** Weinm. ex Fr. Syst. Myc., iii. 145 (1829) (with many curves). Plasmodium white. Sporangia sessile, scattered, forming elongated plasmodiocarps, laterally compressed, sinuous or branched, equal in breadth from the base to the flattened upper ridge, which at length splits longitudinally; sometimes pulvinate and bursting irregularly; white, grey, or yellowish; sporangium-wall double, the outer layer with copious deposits of lime, smooth or reticulated, the inner layer wrinkled and colourless, membranous, usually adhering to the outer layer. Capillitium consisting of numerous white, often branching large and small lime-knots, connected by rather short hyaline threads. Spores violet-brown, spinulose, 8 to 10 μ diam.—Rost. Mon., 112; Mass. Mon., 305; Macbr. N. Am. Slime-Moulds, ed. 2, 52. *Reticularia sinuosa* Bull. Champ., 94, t. 446, fig. 3 (1791). *Physarum bivalve* Pers. in Usteri Ann. Bot., xv. 5 (1795); Lister Mycetozoa, 57. *Angioridium sinuosum* Grev. Scot. Crypt. Fl., t. 310 (1828). *Diderma valvalum* Fr. Syst. Myc., iii. 109 (1829). *D. contortum* Fuckel Symb. Myc., 341 (1869). *Carcerina valvata* Fr. Summ. Veg. Scand., 451 (1849).

Pl. 49.—*a*. sporangia (Essex); *b*. capillitium and spores, with fragment of sporangium-wall; *c*. spore.

The characters of this abundant and widely distributed species are retained on the whole with great constancy. It is closely allied to both *P. bitectum* and *P. bogoriense*, differing from the former in having the inner sporangium-wall wrinkled and colourless, in the smaller lime-knots, and in the uniformly spinulose spores, and from the latter species in the dehiscence of the sporangia along the upper ridge only, and in the larger darker spores.

Hab. On dead leaves and twigs; frequent from summer to winter in most English counties; widely distributed throughout Europe, Canada, and the United States; recorded also from the Cape, Ceylon, Java, Japan, and Chili.

50. **P. bogoriense** Racib. in Hedw., xxxvii. 52 (1898) (Buitenzorg, Java). Plasmodium ? Sporangia scattered or gregarious, sessile on a narrow base, ovoid and somewhat angular, or forming flexuose plasmodiocarps, varying in colour from reddish-brown to buff, yellow or nearly white; outer sporangium-wall smooth, white on the inner side, densely charged with white lime-granules; this layer is usually areolated with pale lines along which it breaks and separates in reflexed lobes from the more persistent membranous inner wall. Capillitium consisting of numerous large white smooth-walled rounded and branching lime-knots connected by slender hyaline threads. Spores pale violet-brown, nearly smooth, 7·5 to 8·5 μ diam.—Petch in Ann. Perad., iv. 238; Brandza in Ann. Sc. de l'Univ. Jassy, xi. 120; Macbr. N. Am. Slime-Moulds, ed. 2, 54. *Diderma pallidum* Berk. & Curt. in Grev., ii. 52 (1873) undescribed. *Physarum pallidum* Lister in Journ. Bot.,

xxxvi. 117 (1898); Sturgis in Colo. Coll. Publ., Sc. Ser. xii., 20.

Pl. 50.—*a*. sporangia (Antigua); *b*. capillitium and spores, with fragment of double sporangium-wall; *c*. spore.

Distinguished from *P. sinuosum* by the sporangia dehiscing by more or less reflexed lobes and by the paler smoother spores.

Hab. On dead leaves: widely distributed throughout the tropics; recorded also from Moldavia, Portugal, the Cape, Brisbane, the southern United States and Pennsylvania.

51. **P. bitectum** Lister Mycetozoa, ed. 2, 78 (1911) (*bis* (*bi*) twice, *tectum* covered). Plasmodium white. Sporangia scattered, sessile, and either subglobose or obovoid, 0·6 to 0·8 mm. diam., or forming curved and flexuose plasmodiocarps 2 to 6 mm. long, rounded, or laterally compressed, smooth, white or buff, sometimes shining purplish-brown below or all over from absence of lime; sporangium-wall double, the outer wall densely charged with white lime-granules, free and deciduous above, recurved and persistent below; inner wall smooth, membranous, pale purplish, more persistent. Capillitium a network of hyaline threads, with numerous variously shaped large smooth-walled white lime-knots. Spores 10 to 12 μ diam., dark purplish-brown, spinulose, with a paler smoother area of dehiscence.—Macbr. N. Am. Slime-Moulds, ed. 2, 53. *P. Diderma* Lister *non* Rost. in Journ. Bot., xxix. 260 (1891) & Mycetozoa, 57; Sturgis in Colo. Coll. Publ., Sc. Ser. xii. 20.

Pl. 51.—*a*. sporangia (Bedfordshire); *b*. capillitium and spores, with fragment of double sporangium-wall; *c*. spore.

This species is allied to *P. sinuosum* with which it is often associated in the south of England, and from which it differs constantly in having a smooth purplish inner sporangium-wall and rougher spores smoother and paler on one side. In the first edition of the present work this species was referred to *P. Diderma* Rost.; a subsequent more complete translation of Rostafinski's description shows *P. Diderma* to have had crowded globose sporangia, characters inapplicable to the present species, for which therefore a new name, *P. bitectum*, was adopted. In the absence of the type from Warsaw, the position of *P. Diderma* remains uncertain, but the description agrees with *P. didermoides* var. *lividum*.

Hab. On dead leaves and twigs; abundant in most English counties in autumn and winter; recorded from Sweden, France, Germany, Portugal, the Cape, New South Wales, the western United States, and Venezuela.

52. **P. testaceum** Sturgis in Colo. Coll. Publ., Sc. Ser. xii, 18 (1907) (*testa* a tile or shell). Plasmodium ? Sporangia sessile, white, subglobose, clustered and polygonal from mutual pressure, 0·7 mm. diam.; outer sporangium-wall white, eggshell-like, separating from the membranous colourless inner wall. Capillitium consisting of numerous large and small angular branching white lime-knots connected by short hyaline threads. Spores purplish-brown or greyish-purple, spinulose, distinctly darker and more spinulose on one side,

8 to 10 μ diam.—*P. didermoides* var. *lividum* Lister in Journ. Bot., xxxvi. 162 (1898), in part. *P. Diderma* Macbr. N. Am. Slime-Moulds, ed. 2, 55 (1922).

Pl. 54.—*a*. sporangia (Colorado); *b*. capillitium and spores; *c*. spore.

This species is closely allied to *P. didermoides* var. *lividum*, from which it differs in the shell-like outer sporangium-wall, the large branching lime-knots and paler spores; it has hitherto been recorded only from the United States, where it appears to be widely distributed. In a specimen from Ouray, Colorado, gathered by Prof. Bethel, every sporangium has a large white hollow columella; this appears to be an exceptional feature.

Hab. On dead wood. Not uncommon in New England; recorded also from Ohio, Michigan, Iowa, Oregon and Colorado.

53. **P. contextum** Pers. Syn. Fung., 168 (1801) (woven together). Plasmodium yellow. Sporangia sessile, subglobose, ovoid, 0·4 to 0·6 mm. diam., or reniform and elongated on a broad base, free or usually crowded in large colonies, often angled by mutual pressure, rounded or flattened above, smooth, yellowish-white or ochraceous; sporangium-wall double, the outer layer thick with dense deposits of lime, often breaking away in the upper part from the thin colourless inner layer. Capillitium with scanty hyaline threads and numerous large irregularly branching white or yellowish lime-knots. Spores dark violet-brown, spinulose, 10 to 13 μ diam.—Rost. Mon., 109; Macbr. N. Am. Slime-Moulds, ed. 2, 56. *Diderma contextum* Pers. Obs. Myc., 1. 89 (1796). *D. ochroleucum* Berk. & Curt. in Grev., ii. 52 (1873). *D. flavidum* Peck in Rep. N.Y. State Mus., xxviii. 54 (1879). *Physarum conglomeratum* Mass. Mon., 304 (1892). *Lycoperdon luteum* Jacq. Misc., 138, t. 8 (1778)? *Leocarpus contextus* Fr. Summ. Veg. Scand., 450 (1849).

Var. **Mortoni** G. Lister (Prof. Morton E. Peck). Sporangia loosely clustered.—*Physarum Mortoni* Macbr. l.c., 58 (1922).

Pl. 55.—*a*. sporangia (Surrey); *b*. capillitium and spores, with fragment of sporangium-wall; *c*. spore.

The present species is closely allied to *P. conglomeratum*, from which it differs in the larger rougher spores and in the structure of the sporangium-wall. The type of *Diderma ochroleucum* Berk. & Curt. from Pennsylvania (K. 1533) is typical *P. contextum*. The var. *Mortoni* has been found several times in Oregon by Prof. Morton E. Peck, and also by Prof. Bethel in Colorado; it appears to be constant in the more scattered habit.

Hab. On dead leaves and twigs; frequent in England from summer to winter; widely distributed in Scotland and throughout Europe, Canada and the United States; recorded also from South Australia and Tasmania.

54. **P. conglomeratum** Rost. Mon., 108, figs. 73, 79, 90 (1875) (*con* together, *glomerare* to collect). Plasmodium? Sporangia subglobose, sessile on a broad base, crowded, angled by mutual pressure, 0·3 to 0·5 mm. broad, pale yellow or buffish-white, mottled with paler shades; sporangium-wall double, the inner layer of the convex upper wall having

translucent pale yellow curved thickened areas, with a vitreous fracture; the outer layer thick, with deposits of easily crumbling yellow lime-granules. Capillitium consisting of slender branching hyaline threads, with numerous white or yellowish branching often confluent lime-knots. Spores pale violet-brown, almost smooth, 8 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 57. *Spumaria minuta* Schum. Enum. Pl. Saell., ii. 196 (1803) ? *S. granulata* Schum. l.c. ? *Diderma conglomeratum* Fr. Syst. Myc., iii. 110 (1829) ? *D. minutum* Fr. l.c., 111 ? *D. granulatum* Fr. l.c. ? *D. flavum* Weinm. Hymen. & Gastrom., 593 (1836) ? *D. rugulosum* Weinm. l.c., 594 ? *Leocarpus granulatus* Fr. Summ. Veg. Scand., 451 (1849) ? *L. minutus* Fr. l.c., 450 ? *Carcerina conglomerata* Fr. l.c., 451 ? *Physarum Rostafinskii* Mass. Mon., 301 (1892).

Pl. 56.—*a*. sporangia (Germany); *b*. capillitium and spores, with fragment of sporangium-wall; *c*. spore.

This species usually forms smaller clusters than the preceding but is mainly distinguished by microscopic characters which the earlier authors were unable to detect; the synonymy quoted above is therefore uncertain, and may refer in part to *P. contextum*. Fries distinguished *Diderma conglomeratum* from *D. contextum* chiefly by the difference of the capillitium; he describes the presence of a columella in both species, but speaks of the deposits of lime as being more largely developed in *D. conglomeratum*. This is an uncertain character, and varies in different gatherings. Rostafinski was the first to detect the main specific difference, and pointed out that in *Physarum contextum* the spores are rough and measure 10 to 13 μ, while in *P. conglomeratum* they are nearly smooth and measure 8 to 9 μ diam. He follows Fries in referring to a columella in *P. conglomeratum*, but adds that it is free and not always evident; he describes *P. contextum* as being usually without a columella. The specimen K. 1277 marked *Diderma conglomeratum* by Fries, gathered in West Sweden and taken by Massee as his type of *P. conglomeratum* (l.c. 304) is typical *P. contextum*; the name *P. Rostafinskii* Mass., which is given to supersede *P. conglomeratum* Rost. is therefore unnecessary.

Hab. On dead leaves and twigs; occurring in many English counties throughout the year; recorded from North Wales, Scotland, Clare Island, France, Germany, Sikkim, India, Pennsylvania, Tennessee, Louisiana, and Antigua.

55. **P. Serpula** Morgan in Journ. Cinc. Soc. Nat. Hist., xix. 29 (1896) (a genus of marine worms). Plasmodium greenish-yellow to yellow. Sporangia sessile, subglobose or forming long straight or flexuose, simple, branched or ring-shaped plasmodiocarps, 0·3 mm. diam., yellow or ochraceous; sporangium-wall membranous, with dense evenly distributed deposits of yellow lime-granules. Capillitium consisting of numerous angular and branching pale yellow lime-knots, connected by short and scanty hyaline threads. Spores purplish-brown, spinulose, with a paler and smoother area of dehiscence, 10 to 12 μ diam.—Lister in Journ. Bot., xxxvi. 116 (1898); Macbr. N. Am. Slime-Moulds, ed. 2, 49. *P. gyrosum* Mass. Mon., 307

(1892), in part. *Badhamia decipiens* Lister Mycetozoa, 32 (1894), in part.

Pl. 57.—*a*. plasmodiocarp (Philadelphia); *b*. capillitium and spores, with fragment of sporangium-wall; *c*. spore.

Various attempts were made to unite this well-marked form with previously known species, until the late A. P. Morgan gave it specific rank. In Schweinitz's herbarium at Philadelphia it was named *P. reticulatum* Alb. & Schw. (syn. *Cienkowskia reticulata* Rost.); it was distributed as *P. gyrosum* Rost. by Ellis (N. Am. Fungi, No. 1396); and in the first edition of the present work it was included under a nearly related species, *Badhamia decipiens* Berk.; from this it differs in the paler lime-knots being connected by hyaline threads, and in the spores being distinctly paler and smoother on one side.

Hab. On dead leaves. Recorded from the States of Pennsylvania, Virginia, Ohio and Iowa.

56. **P. aeneum** R. E. Fries in Arkiv. Bot., i. 62 (1903) (made of brass). Plasmodium ? Sporangia sessile, subglobose, or forming straight or curved simple branching or netlike plasmodiocarps, 0·3 to 0·4 mm. diam., pinkish-brown or bronze colour, glossy; outer sporangium-wall somewhat cartilaginous, brown, brittle, with deposits of lime-granules, separating and folding back above from the shining membranous inner wall. Capillitium a network of hyaline threads with numerous rather small round or angular dark or pale brown lime-knots which sometimes unite to form a pseudo-columella. Spores pale brownish-lilac, nearly smooth, 6 to 10 μ diam.—*P. murinum* var. *aeneum* Lister in Journ. Bot., xxxvi. 117 (1898).

Pl. 58.—*a*. sporangia (Bolivia); *b*. capillitium and spores, with fragment of sporangium-wall; *c*. spore.

This species was first discovered by the Rev. W. Cran in the island of Dominica in 1897; in July 1902 it was collected in Bolivia by Dr. R. E. Fries, who established its right to specific rank; since then large gatherings have been made in the island of Santa Cruz, West Indies, by Prof. C. Raunkiaer; it was found also at Serampore, Bengal, by Mr. J. Drake in 1918, on fern pinnules.

Hab. On dead palm leaves, twigs, &c.—Antigua, Dominica, and Santa Cruz, West Indies, Bolivia, and Bengal.

57. **P. rubiginosum** Fries Symb. Gast., 21 (1817) (rusty). Plasmodium orange-red. Sporangia subglobose, 0·5 to 1 mm. diam., sessile, gregarious or clustered, smooth or rugulose, scarlet, reddish- or olive-brown; sporangium-wall membranous, with dense included clusters of orange lime-granules. Capillitium an abundant network of hyaline threads with frequent triangular membranous expansions at the axils of the branches; lime-knots large, angular, branching, orange-red or red-brown. Spores pale violet-brown, minutely spinulose, 8 to 11 μ diam.—Rost. Mon., 104; Blytt in Bidr. Norg., Sop., iii. 4; Schröter in Cohn Krypt. Fl. Schles., iii. 129; Mass. Mon., 302; Macbr. N. Am. Slime-Moulds, ed. 2, 62. *P. fulvum* Fr. Syst. Myc.,

iii. 143 (1829). *Leangium rubiginosum* Fr. Stirp. Femsj., 83 (1825).

Pl. 59.—*a*. sporangia (Brandenburg); *b*. sporangia (New York); *c*. capillitium and spores, with fragment of sporangium-wall; *d*. spore.

Closely allied to *P. auriscalpium* and *P. lateritium*; from the former it differs in the sessile habit of the sporangia and in the more abundant sometimes elastic network of the capillitium; from *P. lateritium* in the redder and more angular lime-knots. A gathering from Philadelphia sent by Mr. Wingate to Mr. Massee under the unpublished name *Leocarpus squamulosus* has glossy red-brown sporangia and dark red-brown capillitium; another from Gaddonfield, New York, collected by Dr. Sturgis, has similar capillitium and orange-red sporangia fading where exposed to strong light to a dull ochraceous colour; in all other respects these gatherings agree with the typical form of *P. rubiginosum*.

Hab. On dead wood and beds of moss.—Norway, Sweden, France, Germany, Switzerland, New York and Pennsylvania.

58. **P. lateritium** Morgan in Journ. Cinc. Soc. Nat. Hist., xix. 23 (1896) (brick red). Plasmodium yellow-orange. Sporangia subglobose, 0·3 to 0·7 mm. diam., sessile, or forming simple branched or netlike plasmodiocarps, terete or laterally compressed, gregarious, more rarely clustered, orange, brick-red, rosy-red, or red-brown, somewhat rugose, rupturing irregularly; sporangium-wall membranous, colourless above, yellow at the base, with included clusters of red or orange lime-granules. Capillitium a network of slender colourless or pale yellow threads, with rounded lime-knots varying in shape and size, either orange, or with red centres surrounded by round yellowish lime-granules. Spores pale brownish-lilac, almost smooth, 6 to 9 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 50. *Didymium lateritium* Berk. & Rav. in Grev., ii. 65 (1873). *D. croceoflavum* Berk. & Br. in Journ. Linn. Soc., xiv. 84 (1875). *Physarum Braunianum* de Bary ex Rost. Mon., 105 (1875). *P. Ditmari* γ *lateritium* Rost. l.c., App. 9 (1876). *Physarum Ditmari* β *croceoflavum* Rost. l.c. *P. inaequale* Peck in Rep. N. York Mus. Nat. Hist., xxxi. 40 (1879). *P. chrysotrichum* Mass. Mon., 300 (1892), in part. *P. fulgens* Pat. in Bull. Soc. Myc. Fr., viii. 122 (1892) ?

Pl. 60.—*a*. sporangia (South Carolina); *b*. sporangia (Philadelphia); *c*. capillitium and spores, with fragment of sporangium-wall; *d*. spore.

Pl. 61.—*d*. sporangia of type of *P. Braunianum* de Bary (Berlin).

This species is variable in the colour and shape of the sporangia; the bright red form almost merges into *P. rubiginosum*, but is usually distinguished by the paler more rounded lime-knots; the orange form appears to be nearly allied to *P. virescens*, but differs in the sporangia being more scattered and having a tendency to form long slender plasmodiocarps, which are often pale yellow or grey in the lower part. A specimen on soil from Carolina marked *Didymium terrigenum* Berk. & Curt. (B.M. 575) is in poor condition but seems to be the present species rather than *P. virescens*, with which it was placed in the first edition of this work. Dr. Jahn has recently found in the herbarium of the Berlin Museum the type of *P. Braunianum* de Bary, collected in June 1852 on moss in Grünewald near

Berlin, by A. Braun. The minute sporangia are globose, clustered or scattered, 0·2 to 0·3 mm. diam., purplish-brown and without lime-deposits, or spotted and veined with clusters of brick-red lime-granules; the scanty capillitium consists of slender hyaline threads and yellow or nearly white lime-knots; the spores are violet-grey, 9 μ diam.; the specimen is not perfectly developed, and it is a question whether it should be placed with *P. virescens* or *P. lateritium* but the brick-red colour of the sporangia favours the latter position. The present species was found in abundance in bramble thickets by Mr. H. J. Howard in Norfolk woods in the summer and autumn of 1916, 1917, 1919.

Hab. On dead leaves, twigs and wood.—Staffordshire, Norfolk, Germany, Switzerland, Moldavia, Ceylon, Malaya, Java, the United States, Brazil, and Chili.

59. **P. virescens** Ditm. in Sturm Deutsch. Fl., Pilze, i. 123, t. lxi (1817) (becoming green). Plasmodium lemon-yellow. Sporangia subglobose or irregularly ovoid, 0·2 to 0·4 mm. diam., sessile, heaped or gregarious, rugose or nearly smooth, pale yellowish-green, orange-yellow, or purple-brown from the absence of lime; sporangium-wall membranous, with dense included clusters of minute yellow lime-granules, rarely without lime. Capillitium a network of hyaline threads with fusiform or irregular yellow lime-knots. Spores pale violet-brown, 7 to 10 μ diam., minutely spinulose, the spinules either equally distributed, or slightly clustered.—Rost. Mon., 103; Mass. Mon., 277; Macbr. N. Am. Slime-Moulds, ed. 2, 61. *P. thejoteum* Fr. Symb. Gast., 21 (1818); *P. caespitosum* Schwein. in Tr. Am. Phil. Soc., iv. 258 (1832). *P. Ditmari* Rost. l.c., App. 8 (1876). *Didymium nectriæforme* Berk. & Curt. in Grev., ii. 66 (1873). *D. sinapinum* Cooke Myx. Brit., 33 (1877).

Var. **obscurum** Lister Mycetozoa, 59 (1894) (dark). Sporangia sessile, 0·4 to 0·8 mm. diam., subglobose or forming plasmodiocarps, gregarious or crowded, greenish-grey, often spotted with pale yellow or olive-brown, somewhat glossy; sporangium-wall membranous, colourless above, yellow at the base, either without lime, or with widely scattered clusters of whitish lime-granules: lime-knots bright yellow: spores 6 to 8 μ diam.

Var. **nitens** Lister (bright). Sporangia subglobose, 0·5 to 0·9 mm. diam., sessile, gregarious or clustered, bright yellow or orange: spores 7 to 9 μ diam.—*P. luteolum* Peck in Rep. N. York Mus. Nat. Hist., xxx. 50 (1878) ?; see Sturgis in Trans. Conn. Ac., x. 470 (1900). *P. auriscalpium* Macbr. (*non* Cooke) in Bull. Nat. Hist. Iowa, ii. 158 (1893).

Pl. 61.—*a*. sporangia (Essex); *b*. capillitium and spores, with fragment of sporangium-wall, showing three of the calcareous discs; *c*. spore; *d*. sporangia of var. *obscurum* (Devon).

Pl. 62.—*a*. sporangia of var. *nitens* (Maine); *b*. capillitium and spores, with fragment of sporangium-wall; *c*. spore.

Glycerine mountings of the typical form show, dispersed in the sporangium-wall, flattened disc-shaped crystalline bodies with a radiating

structure, measuring 10 to 20 μ diameter. These are also found in the sporangium-wall of *P. psittacinum*, *P. digitatum*, and *Craterium leucocephalum*; they do not appear to be present in vars. *obscurum* and *nitens*. The var. *obscurum* has been found frequently in England, and has also been recorded from Scotland, Hungary, and the Adirondack Mts., New York; the capillitium and spores are similar to the typical form, but in external appearance it differs markedly in the larger and more scattered sporangia with glossy and almost limeless walls. The var. *nitens* is a handsome form, having rather larger sporangia than the type, with which it is connected by gatherings intermediate in character. A robust form of this variety is seen in two gatherings from Somerset, made in 1916 and 1922, in which the orange-yellow sporangia are either globose or form stout plasmodiocarps, from 1 to 1·8 mm. long, clustered on an orange hypothallus. Dr. Sturgis has examined the scanty and injured remains of the type of *P. luteolum* Peck in the New York State Museum at Albany; he regards it as being probably *P. virescens* var. *nitens*, and considers that Peck's name should be discarded (see Sturgis l.c.).

Hab. On dead leaves, moss and twigs, rarely on wood; probably not uncommon throughout England and Scotland, widely distributed in Europe, the United States and Canada: var. *obscurum* recorded from Devon, Bedfordshire, Essex, Norfolk, Northumberland, Wigtownshire, Aberdeen; also from Hungary and Roumania: var. *nitens* recorded from Surrey, Bedfordshire, Warwickshire, Somerset, Aberdeenshire, Co. Kerry, Bohemia, New England and Iowa State.

60. **P. digitatum** Farquh. & G. Lister in Journ. Bot., liv. 128 (1916), Pl. 541, figs. 1, 1*a*, *b* (*digitus* a finger). Plasmodium greyish-yellow. Sporangia subglobose or cylindrical, ascending, simple or branched and irregularly lobed, closely clustered, sessile, tawny or clay-coloured, 0·1 to 0·3 mm. diam., 0·3 to 1 mm. high, seated on a membranous hypothallus; sporangium-wall membranous, with abundant deposits of clay-coloured lime-granules, and with a few scattered crystalline discs. Capillitium a network of hyaline threads with fusiform or angular yellowish-brown lime-knots which may unite to form a pseudo-columella. Spores pale violet-grey, 5 to 6 μ diam., marked with small scattered clusters of minute warts; from three to five of these clusters are seen on the hemisphere. *P. thejoteum* Morgan in Journ. Cinc. Soc. Nat. Hist., xix. 22 (1896); Macbr. N. Am. Slime-Moulds, 36 (1899). *P. instratum* Macbr. l.c., ed. 2, 62 (1922).

Pl. 203.—*a*. group of sporangia; *b*. capillitium and spores, with fragment of sporangium-wall; *c*. spores.

This inconspicuous species forms large colonies on decaying wood. It is distinguished from *P. virescens*, its near relative, by the clay-coloured, often cylindrical sporangia, and by the smaller spores spotted with scattered clusters of warts. The specimens from South Nigeria and the Cape Province, collected by C. O. Farquharson and Miss A. V. Duthie respectively, have the majority of the sporangia cylindrical. Specimens from Ohio and Iowa, courteously sent us by Prof. Macbride, have both ovoid and globose sporangia; they are clearly forms of the same species.

Hab. On dead wood.—Agege, South Nigeria; Knysna Forest, Cape Province; Ohio, Illinois, Iowa, Missouri, Nebraska.

61. **P. alpinum** G. Lister in Journ. Bot., xlviii. 73 (1910). Plasmodium ? Sporangia clustered or scattered, sessile, subglobose, 1 to 1·3 mm. diam., or forming curved or straight plasmodiocarps 2 to 30 mm. long, pale yellow or ochraceous, scaly or smooth ; outer sporangium-wall densely charged with calcareous deposits, separating from the membranous inner wall. Capillitium with abundant and rather large simple or branching yellow lime-knots connected by a scanty network of firm hyaline threads with broad membranous expansions. Spores purple-brown, closely and minutely warted, 9 to 14 μ diam.—R. E. Fries in Svensk Bot. Tidskr., vi. 743 (1912) ; Macbr. N. Am. Slime-Moulds, ed. 2, 54. *P. virescens* var. *alpina* Lister in Journ. Bot., xlvi. 216 (1908).

Pl. 62.—*d*. sporangia (California) ; *e*. capillitium and spores, with fragment of sporangium-wall ; *f*. spore.

This species was first gathered in the Blue Cañon, California, by Dr. Harkness (B.M. 2327), and was named in Phillips's herbarium *Badhamia inaurata* (see Mycetozoa, ed. 1, p. 61). It has been found on the Belalp and near Arolla, Switzerland, 8,000 feet altitude ; M. Ch. Meylan has repeatedly gathered it in the Jura Mountains, near Ste. Croix at an elevation of from 3,000 to 4,000 feet, where it appears on turf on the mountain-side associated with *P. vernum* after the thawing of the winter snows. In general structure and in the colour of the spores the present species is curiously like the alpine form of *P. vernum*, though differing entirely in the yellow colour of the sporangia and lime-knots. It appears to be related to *P. virescens* var. *nitens*, but is distinguished by the double sporangium-wall, the frequent plasmodiocarp habit, and the larger darker spores.

Hab. On grass, leaves and sticks in alpine regions.—Jämtland (Sweden), Switzerland, Washington State (*teste* Macbride) and California.

Genus 4.—**FULIGO** Haller Hist. Stirp. Helv., iii. 110 (1768) (soot). Sporangia elongated, branching and interwoven, combined to form a pulvinate aethalium, the outer layer of sporangia often barren and forming a cortex charged with deposits of lime-granules and without spores ; capillitium with few or many lime-knots.

KEY TO THE SPECIES OF *FULIGO*.

Aethalium and lime-knots yellow, less often reddish or white ; spores 7 to 9 μ. 1. *F. septica*

Aethalium yellowish-grey ; lime-knots numerous, orange-yellow ; spores 10 to 11 μ. 2. *F. muscorum*

Aethalium and lime-knots pure white, the latter large ; spores 10 to 14 μ, often ellipsoid. 3. *F. cinerea*

Aethalium white ; spores 15 to 20 μ, tuberculate. 4. *F. megaspora*

1. **F. septica** Gmelin Syst. Nat., 1466 (1791) (σηπτῐκός decaying). Plasmodium yellow, rarely white. Aethalia

pulvinate, varying much in size, from 2 mm. to 20 cm. broad, yellow. The sporangia constituting the aethalium are intricately coiled and anastomosing, 2 to 2·5 mm. broad, with air spaces in the intervals which permeate the mass ; cortex yellow, thick, thin or wanting, when the surface is greenish-grey and marked with brain-like coils of the perfect sporangia ; sporangium-walls within the aethalium membranous, very fragile, colourless with scattered deposits of lime-granules. Columella none. Capillitium scanty or abundant, consisting of a loose network of slender hyaline threads more or less expanded at the axils, with fusiform or branching yellow lime-knots, varying much in size. Spores violet, almost smooth, 6 to 8 μ, rarely 8 to 10 μ diam.—Blytt in Bidr. Norg., Sop., iii. 5 ; Macbr. N. Am. Slime-Moulds, ed. 2, 27. *Mucor septicus* Linn. Sp. Pl., ed. 2, 1656 (1763). *M. primus* (*ovatus*) Schaeff. Fung. Bav., 132, fig. 192 (1763). *M. Mucilago* Scop. Fl. Carn., ii. 492 (1772). *Reticularia lutea* Bull. Champ., 87, t. 380, fig. 1 (1791). *R. hortensis* Bull. l.c., 86, t. 424, fig. 2. *R. carnosa* Bull. l.c., 85, t. 424, fig. 1. *R. ovata* Wither. Br. Pl., ed. 4, iv. 463 (1801). *R. septica* Wither. l.c. *R. vaporaria* Chev. Fl. Par., i. 342 (1826). *Fuligo flava* Pers. in Roemer, N. Mag. Bot., i. 88 (1794). *F. vaporaria* Pers. Obs., i. 92 (1795). *F. laevis* Pers. Syn. Fung., 160 (1801). *F. violacea* Pers. l.c. ; Macbr. l.c., ed. 1, 24. *F. flavescens* Schum. Enum. Pl. Saell., ii. 194 (1803). *F. varians* Somm. Fl. Lapp., 239 (1826) ; Rost. Mon., 134 ; Mass. Mon., 340. *F. tatrica* Racib. in Hedw., xxiv. 169 (1885). *F. ovata* Macbr. l.c., 23 (1899). *F. cerebrina* Brondeau in Mém. Soc. Linn. Paris, iii. 74 (1825). *Aethalium flavum* Link in Berl. Mag., Diss., i. 42 (1809). *A. septicum* Fr. Syst. Myc., iii. 93 (1829). *A. violaceum* Spreng. Syst. Veg., iv. 533 (1827).

Var. **candida** R. E. Fries in Svensk Bot. Tidskr., vi. 744 (1912) (white). Plasmodium cream-white ; aethalia and lime-knots white.—*F. candida* Pers. Obs., i. 92 (1795). *Aethalium candidum* Schlecht in Spreng. l.c.

Var. **rufa** R. E. Fries l.c., 745 (red). Plasmodium yellow or cream-coloured ; aethalia and lime-knots dull brick-red.—*F. rufa* Pers. in Roemer, N. Mag. Bot., i. 88 (1794). *F. carnea* Schum. l.c., 194? *Reticularia carnea* Fr. l.c., 91? *R. rufa* Schwein. in Tr. Am. Phil. Soc., iv. 261 (1832). *Aethalium ferrincola* Schwein. l.c. *A. rufum* Wallr. Fl. Crypt. Germ., ii. 341 (1833). *Licea Lindheimeri* Berk. in Grev., ii. 68 (1873). *Tubulina Lindheimeri* Mass. Mon., 42 (1892).

Pl. 74.—*a*. part of a small ecorticate aethalium (Essex) ; *b*. white aethalium (Hants) ; *c*. reddish aethalium of var. *rufa* (Essex) ; *d*. capillitium and spores from aethalium '*c*' ; *e*. capillitium and spores from aethalium '*a*' ; *f*. spore.

This conspicuous species has received the popular English name of 'Flowers of Tan' from its frequent occurrence in tan-yards on heaps of spent tan. It is perhaps the most abundant and widely distributed of all

the Mycetozoa. The aethalia vary much in size, in colour, and in the amount to which the cortex is developed. It is found that if the rising plasmodium is protected by a bell-glass from currents of dry air, the sporangia develop well throughout, there is no cortical layer, and a number of small aethalia may be formed rather than a single large one; when, on the other hand, the young aethalium is exposed to dry winds or sunlight, the cortex becomes thick from the outer layers of sporangia containing no spores. Occasionally the lime in the sporangium-walls is in the form of crystalline nodules. In the type of *Licea Lindheimeri* Berk.* from Texas (K. 1648) only the basal part of an aethalium remains; it is an orange form of var. *rufa* with scanty capillitium and violet spores measuring 5 to 7 μ. An unusual habitat for the present species was seen when a number of yellow aethalia appeared on the skull of a whale exposed for cleaning purposes in the grounds of the British Museum, South Kensington; fresh aethalia continued to develop during the summers of 1913 and 1914; the plasmodium must almost certainly have been feeding on the animal matter remaining in the spongy tissue of which the skull is composed.

Hab. On dead wood, leaves, &c., in summer. The yellow and white forms are abundant in temperate and tropical regions; var. *rufa* is less frequent but is also widely distributed.

2. **F. muscorum** Alb. & Schwein. Consp. Fung., 86, t. vii, fig. 1 (1805) (*muscus* moss). Plasmodium apricot-yellow, translucent. Aethalia pulvinate or effused, 2 mm. to 5 cm. in diam., scattered, clustered or somewhat imbricated, nearly smooth, formed of very closely interwoven sporangia, yellowish-grey or grey, seated on a pale orange hypothallus; cortex scanty or none; sporangium-wall membranous with scattered deposits of orange lime-granules. Capillitium of numerous irregular often branching orange lime-knots connected by rather short hyaline threads. Spores violet-brown, spinulose, 10 to 11 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 25. *Lignidium griseoflavum* Link in Mag. Ges. Nat. Fr. Berl., iii. p. 24 (1809). *L. muscicola* Fr. Symb. Gast., 10 (1817). *L. reniforme* Fr. l.c. ? *Reticularia muscorum* Fr. Syst. Myc., iii. 91 (1829). *Physarum gyrosum* Rost. Mon., 111 (1875), in part. *P. muscorum* Berl. in Sacc. Syll. Fung., vii. 346 (1888), in part. *Licea ochracea* Peck in Rep. N. York Mus. Nat. Hist., xxviii. 55 (1876). *Fuligo ochracea* Peck l.c., xxxi. 56 (1879); Mass. Mon., 342; Lister Mycetozoa, 67 (1894). *F. simulans* Karst. in Bidr. Känn. Finl. Nat., xxxi. 108 (1879).

Pl. 77.—*a.* aethalium, on moss (Surrey); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

This species differs from *F. septica* in the smooth clustered aethalia, in the orange lime-knots connected by short hyaline threads, and in the larger darker rougher spores. In some seasons the plasmodium is abundant

* Through the courtesy of Prof. Macbride we have had the opportunity of examining the specimen described under the name of *Licea Lindheimeri* Berk. by Morgan (see Macbr. N. Am. Slime-Moulds, 147, t. xii, figs. 6, 6*a*, 6*b*); it is an ascomycetous fungus belonging to the Order *Perisporiacei*, probably a species of *Emericella*.

on turf, rushes, &c., on moist moorland, occurring in masses many inches across, and creeping up the adjacent plants to form on the under surface of their stems and leaves numerous rounded aethalia, whose dingy colour when mature and dry renders them inconspicuous. When protected from currents of air, the sporangia form less compact aethalia, and may in part remain free as simple or branched plasmodiocarps.

Hab. On sticks, rushes, bracken, moss, &c., in moist places, not unfrequent in the British Isles in summer and winter. Recorded from Essex, Surrey, Berkshire, Bedfordshire, Devon, Somerset, Salop, Yorkshire, Northumberland, North Wales, North Scotland, Co. Mayo; France, Sweden, Germany, Switzerland, Ceylon, New England.

3. **F. cinerea** Morg. in Journ. Cinc. Soc. Nat. Hist., xix. 33 (1896) (ashy). Plasmodium white. Aethalia pulvinate, elongate, simple or branched, 4 to 60 mm. long, scattered or gregarious, formed of closely interwoven sporangia usually enclosed in a smooth white cortex densely charged with lime, seated on a white hypothallus. Sporangium-walls within the aethalium more or less perfect, membranous, with deposits of white lime-granules. Capillitium consisting of simple or branched hyaline threads, and large white lime-knots that may unite to form a pseudo-columella, or almost *Badhamia*-like. Spores brownish-violet, spinulose, ellipsoid, 13 to 17 × 8 to 12 μ, or subglobose, 9 to 12 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 26. *Enteridium cinereum* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 261 (1832). *Lachnobolus cinereus* Schwein. l.c. *Physarum ellipsosporum* Rost. Mon., App. 10 (1876); Mass. Mon., 310. *Badhamia coadnata* Rost. Mon., 146 (1875); Mass. l.c., 325. *Aethaliopsis stercoriformis* Zopf Pilzthiere, 150, fig. 26 (1884). *Fuligo stercoriformis* Racib. in Hedw., xxvi. 111 (1887); Mass. l.c., 342. *F. ellipsospora* Lister Mycetozoa, 67; Petch in Ann. Perad., iv. 342.

Var. **ecorticata** Lister l.c., ed. 2, 88 (1911) (without cortex). Aethalia composed of more loosely combined sporangia, irregular in outline, without cortex, white, buff, or pale reddish-brown; spores often globose, 9 to 12 μ diam.—*F. intermedia* Macbr. l.c., 30.

Pl. 75.—*a*. part of an ecorticate aethalium (Beds.); *b*. group of aethalia, on straw; *c*. capillitium and spores; *d*. spore.

The typical form of this widely distributed species has occurred some years in great abundance about heaps of old straw in Bedfordshire, and is not uncommon in the British Isles. Mr. Petch describes it as being fairly abundant in Ceylon. The var. *ecorticata* occurs both on dead leaves and on wood, and is not unfrequent in this country; the spores are usually rather paler and smaller than in the typical form, between which and the white variety of *F. septica* it holds an intermediate position. The type of *Badhamia coadnata* Rost. from Cuba in the Strasburg Herbarium consists of smooth corticate aethalia of the present species. From the description and illustration of *Aethaliopsis stercoriformis* Zopf there can be no doubt that it also is *Fuligo cinerea*. Dr. Sturgis has examined the type of *Lachnobolus cinereus* Schwein. and finds it is a typical form of the present species.

Hab. On dead leaves, straw, &c.—Essex, Bedfordshire, Buckinghamshire,

Sussex, Warwickshire, Somerset, Cheshire ; Germany, Roumania, South Nigeria, Ceylon, New South Wales, Japan, United States, West Indies : var. *ecorticata* recorded from Essex, Elginshire, Nairnshire ; Sweden, Germany, Pennsylvania, Kansas, Colorado and Iowa.

4. **F. megaspora** Sturgis in Colo. Coll. Publ., Sc. Ser. xii. 443, Pl. 2, figs. 1 to 2 (1913) (μέγας large, σπορά seed). Plasmodium ? Aethalia pulvinate with a thick white spongy cortex, white or yellowish below, 15 to 40 cm. diam. ; walls of the closely convolute sporangia membranous, charged throughout with lime-granules 1·5 to 2 mm. diam. Capillitium scanty, somewhat *Badhamia*-like with few hyaline threads connecting the branching lime-knots with the walls. Spores spherical or slightly oval, dark brownish-purple, 15 to 20 μ diam., either uniformly warted or marked with patches of close spinulose reticulation.—Macbr. N. Am. Slime-Moulds, ed. 2, 30.

Pl. 202.—*d*. small aethalium ; *e*. two spores, and fragment of capillitium attached to sporangium-wall ; *f*. spore, showing spines and broken reticulation.

Dr. Sturgis found this striking species in some abundance in two successive years on Cheyenne Mountain, near Colorado Springs ; Dr. R. E. Fries also obtained it near Lake Albert in East Africa.

Hab. On dead wood.—Colorado and East Africa.

Genus 5.—**ERIONEMA** Penzig in Myx. Buit., 36 (1898) (ἔριον wool, νῆμα thread). Sporangia forming long cylindrical simple or branched plasmodiocarps ; capillitium a close elastic network of slender colourless threads with few small lime-knots.

1. **E. aureum** Penz. l.c., 37 (golden). Plasmodium colourless, yellowish or rich chrome yellow. Sporangia long, cylindrical, 0·2 to 0·3 mm. diam., lemon-yellow, or greyish-olive spotted and banded with yellow, either clustered and drooping on slender branched stalks, or sessile and forming straight or curved, branched and often interlacing plasmodiocarps ; sporangium-wall a pale yellow membrane, with more or less abundant deposits of yellow lime-granules. Stalks yellow, filiform, merging into the anastomosing strands of the hypothallus. Capillitium a close persistent network of slender colourless threads with few small fusiform yellow lime-knots ; at maturity the sporangium-wall breaks away in flakes, and the cylindrical network of capillitium expands longitudinally to several times its original length. Spores pale brownish-violet, nearly smooth, 6 to 7 μ diam.—Lister in Journ. Bot., xlii. 98, tab. 458 ; Petch in Ann. Perad., iv. 341.

Pl. 73.—*a*. sporangia (Java) ; *b*. capillitium and spores ; *c*. spore.

The present species is distinguished from *Fuligo septica*, some ecorticate forms of which it resembles, by the remarkable elastic capillitium. *Erionema aureum* was first found by Professor Penzig in the botanic gardens of Buitenzorg, in November, 1896. Mr. A. R. Sanderson observed it several times in Johore, Malay Peninsula, twice on much decayed wood, and once

forming a very large colony on a great polypore ; he also saw the rich chrome yellow plasmodium emerging from a stump (see Trans. Brit. Myc. Soc., vii. 245).

Hab. On dead wood, twigs, &c.—Ceylon, Malay Peninsula, Java, Japan.

Genus 6.—**TRICHAMPHORA** Junghuhn Fl. Crypt. Jav., 12 (1838) (*θρίξ* hair, *ἀμφορεύς* jar). Sporangia discoid or saucer-shaped, stalked ; stalk red-brown ; sporangium-wall membranous, with evenly distributed deposits of lime-granules ; capillitium consisting of colourless branching threads with many or few lime-knots, or of membranous tubes filled with lime throughout, or without lime.

Trichamphora is somewhat artificially separated from the unwieldy genus *Physarum*, to which it is very closely allied, on account of the remarkable saucer-like shape of the sporangia, and from the capillitium being frequently without any deposits of lime.

1. **T. pezizoidea** Jungh. l.c. (like a *Peziza*). Plasmodium greyish-white. Total height 1 to 2·5 mm. Sporangia gregarious, stalked, discoid or saucer-shaped, erect or somewhat inclined, 0·8 to 1·3 mm. broad, 0·2 to 0·4 mm. thick, greyish-white ; sporangium-wall membranous, with thin deposits of lime equally distributed, breaking up at maturity into areolae which remain attached to the capillitium after the dispersion of the spores. Stalk subulate, longitudinally striate, reddish-brown, translucent. Capillitium very variable, consisting either of branching anastomosing colourless threads with broad expansions at the axils and at the attachment to the sporangium-wall, and either with or without fusiform lime-knots, or *Badhamia*-like and formed of membranous tubes filled with lime throughout. Spores dark or pale purplish-brown, spinose, spinulose or nearly smooth, 9 to 17 μ diam.—Lister in Journ. Bot., xxxix. 85, & xlii. 132. *Physarum macrocarpum* Fuckel Symb. Myc., 343 (1869) (*non* Cesati). *P. Muelleri* Berk. MS. in herb. *P. pezizoideum* Pav. & Lag. in Bull. Soc. Myc. Fr., xix. 7, Pl. iv, figs. A1, A2 (1903). *Trichamphora Fuckeliana* Rost. in Fuckel l.c., Nachtr. 2, 71 (1873) ; Rost. Mon., 138. *Didymium zeylanicum* Berk. in Hook. Journ. Bot., vi. 230 (1854). *D. pezizoideum* Mass. Mon., 239 (1892). *D. australe* Mass. in Grev., xvii. 7 (1888). *D. parasiticum* Sacc. & Syd. Syll. Fung., xiv. 836 (1899). *Chondrioderma pezizoideum* Rost. Mon., 424 (1875). *C. zeylanicum* Rost. l.c., App. 15 (1876). *C. Muelleri* Rost. l.c. *C. Berkeleyanum* Rost. l.c., 16. *Badhamia Fuckeliana* Rost. l.c., 2 ; Mass. l.c., 321.

Pl. 72.—*a*. sporangia (Brisbane) ; *b*. capillitium and spores, with fragment of sporangium-wall ; *c*. spore (Brisbane) ; *d*. spore (E. Africa).

This species often forms large plasmodia, resulting in many hundred sporangia. It displays in its various forms all the types of capillitium characteristic of *Badhamia*, *Physarum* and, to some extent, of *Diderma*, and has been published under many names in each of these genera. A large

number of gatherings have now been obtained from many parts of the world, having the characteristic saucer-shaped sporangia and translucent red-brown stalks, but exhibiting great variety both in the amount of lime in the capillitium, and in the size, colour and roughness of the spores. Junghuhn's type from Java is the form with no lime in the slender threads of the capillitium, as also are the types of *Physarum Muelleri* Berk. from Queensland, *Chondrioderma Berkeleyanum* Rost. from Tahite, *Didymium zeylanicum* Berk. & Br. from Ceylon, and *D. australe* Mass. from Brisbane. In the type of *Badhamia Fuckeliana* Rost. from Germany, the capillitium consists of membranous tubes free from lime-granules. A specimen from Togo, East Africa (B.M. 2343), collected by Staudt in 1897 has *Badhamia*-like capillitium and dark echinulate spores 15 μ diam. A large gathering made by Mr. Petch in the Peradeniya Gardens, Ceylon (B.M. 2344), has rather broad and nearly simple capillitium threads with long fusiform lime-knots; the spores are dark, spinulose, and measure 17 μ diam. The specimen B.M. 2052 from the Philippine Islands has slender branching capillitium, small lime-knots, and violet-brown, minutely warted spores measuring 9 μ. The present species appears to be nearly allied to *Physarum javanicum*, but is distinguished by the more saucer-shaped sporangia, the red colour of the stalks and the darker, usually larger spores.

Hab. On dead wood, *Auricularia*, &c.—Abundant throughout the tropics; recorded also from Sweden, France, Germany, Moldavia, Natal, and Japan.

Genus 7. **PHYSARELLA** Peck in Bull. Torr. Bot. Club, xi. 61 (1882) (diminutive of *Physarum*). Sporangia stalked, shortly cylindrical, perforated from above by a deep umbilicus; capillitium consisting of slender threads with minute fusiform lime-knots, and stout spine-like processes arising from the sporangium-wall.

1. **P. oblonga** Morg. in Journ. Cinc. Soc. Nat. Hist., xix (1896). Plasmodium rich yellow. Total height about 3 mm. Sporangia gregarious, stalked, shortly cylindrical, inclined, 0·8 mm. long, 0·6 mm. broad, perforated from above by a deep umbilicus, which is continuous with the hollow stem, greenish- or reddish-yellow; abnormal growths have sporangia erect, funnel-shaped or irregularly expanded; occasionally they are sessile, and form net-like plasmodiocarps; sporangium-wall a yellow membrane thickened with deposits of yellow lime-granules and studded with the spine-like processes of the capillitium, at length dehiscing round the cylindrical apex of the sporangium and recurving in stellate lobes from the wall of the umbilicus, which persists as a hollow orange-yellow columella. Stalk cylindrical, striate, red-brown, translucent, slender, broader at the base, or thick and irregular. Capillitium consisting normally of abundant filiform forking pale yellow threads, with few small fusiform yellow lime-knots, and yellow or orange spine-like processes 0·2 mm. long, 20 μ thick, extending from the outer wall of the sporangium to the walls of the columella, densely charged with granules of lime; in plasmodiocarp forms the capillitium may consist of a network of yellowish

threads with large irregular orange lime-knots, and with no spine-like processes. Spores violet-brown, nearly smooth, 6 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 109. *Trichamphora oblonga* Berk. & Curt. in Grev., ii. 66 (1873). *Physarum rufibasis* Berk. & Br. in Journ. Linn. Soc., xiv. 85 (1873). *P. hians* Mass. Mon., 296 (1892). *Chondrioderma inflatum* Rost. Mon., 425 (1875). *Tilmadoche oblonga* Rost. l.c., App. 13 (1876). *T. hians* Rost., l.c., 14. *T. minuta* Berl. in Sacc. Syll., vii. 361 (1888). *Physarella mirabilis* Peck in Bull. Torr. Bot. Cl., ix. 61 (1882); Lister Mycetozoa, 68; Petch in Ann. Perad., iv. 339. *P. lusitanica* Torr. Fl. Myx., 173 (1909) ?

Pl. 71.—*a.* sporangia (Philadelphia); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* capillitium from an irregularly formed sporangium; *d.* spore.

This species when well formed presents a striking aspect either in the stage where the sporangia are still unbroken, or when they have expanded in a flower-like manner to expose the golden trumpet-shaped columellae and curious spike-like processes of the capillitium. When development has not been perfect irregular distorted sporangia occur. The type of *Physarum rufibasis* Berk. & Br. from Ceylon has open funnel-shaped sporangia on short stout stalks connected below by an ample hypothallus. This is one of the two specimens quoted by Rostafinski as types of his *Tilmadoche hians*; the other is referred to as follows :—'The specimen seen was gathered by Jan Kickx (father) in Flanders, and marked by him *Craterium minutum* Fr.'; it appears to be the only typical example of the present species yet recorded from Europe. A specimen gathered by Mr. W. G. Freeman at Onitcha Olona, Nigeria (B.M. 2349), shows every variety between typical sporangia and net-like plasmodiocarps; the latter have in part the characteristic capillitium, and in part a capillitium consisting of a close network of orange threads with small and large irregular and branching lime-knots. A remarkable form showing close affinity to the present species has been found by Dr. Torrend on the bark and leaves of *Eucalyptus globulus* in the royal park of Alfieti, Portugal, and has been named by him *Physarella lusitanica*. The sporangia are subglobose or lenticular, and for the most part are deeply umbilicate above; in some cases the umbilicus is shallow, in others it is so deep as to be continuous with the stalk; the capillitium consists of a close network of orange threads with few or many large irregular lime-knots, but in one sporangium was almost *Badhamia*-like. If this form should prove constant it may well deserve specific rank.

Hab. On dead wood, &c.; on worm-casts in S. Nigeria.—Abundant throughout the United States and in the tropics; recorded also from the Cape Province.

Genus 8.—**CIENKOWSKIA** Rostafinski Versuch, 9 (1873) (Dr. S. Cienkowski, 1822 to 1887, a Russian botanist). Sporangia forming net-like plasmodiocarps. Sporangium-wall cartilaginous at the base; capillitium a loose network of rigid threads, with free, curved, sharp-pointed branchlets, connected with flat perforated calcareous plates attached at their margins to the sporangium-wall.

1. **C. reticulata** Rost. l.c. (net-like). Plasmodium deep orange-red. Sporangia sessile, scattered, pulvinate, forming

cylindrical simple or branched and net-like plasmodiocarps, 0·5 mm. diam., attached by a narrow base to the substratum, yellow-brown or orange, with transverse pale ridges and waxy crimson spots; sporangium-wall orange-yellow, membranous above, cartilaginous below, marked with the bases of the calcareous plates of the capillitium. Capillitium consisting of an elastic network of flexuose rigid yellow threads with free sharp-pointed uncinate branchlets, and of lime-deposits in the form of flat perforated pale yellow plates disposed transversely to the axis of the sporangium and connected by broad or narrow attachments to the sporangium-wall, occasionally with irregular rounded lime-knots intermixed. Spores clear violet-brown, minutely spinulose, 9 to 12 μ diam.—Rost. Mon., 91; Mass. Mon., 337; Macbr. N. Am. Slime-Moulds, ed. 2, 111; Petch in Ann. Perad., iv. 341. *Physarum reticulatum* Alb. & Schw. Consp. Fung., 90 (1805). *Diderma reticulatum* Fr. Syst. Myc., iii. 112 (1829).

Pl. 70.—*a*. plasmodiocarp (Leicestershire); *b*. portion of a plasmodiocarp with the wall broken and showing vertical plate-like lime-knots; *c*. capillitium and spores; *d*. spore.

The net-like plasmodiocarps of this species are often very extensive, and may cover an area of several inches. On maturity the sporangium-wall usually breaks away above, and the capillitium expands longitudinally to several times its original length and lies in orange-coloured festoons about the surface of the bark, leaving exposed the glossy crimson bases of the net-like plasmodiocarps. On exposure to sunlight the rich red-brown colour of the sporangia is soon lost, and they become blackish-brown, while the capillitium is bleached almost white.

Hab. On dead wood and sticks.—Cornwall, Leicestershire, North Wales, Aberdeen; France, Germany, Portugal, Cape Province, Ceylon, Malaya, Java, New Zealand, Colorado, Iowa.

Genus 9.—**CRATERIUM** Trentepohl in Roth Catal. Bot., i. 224 (1797) (*κρατήρ* bowl). Sporangia stalked, either goblet-shaped, with a lid of thinner substance, or without a distinct lid and obovoid or subglobose; sporangium-wall charged with granules of lime, and cartilaginous at least in the lower part. Capillitium consisting of hyaline threads connecting large lime-knots, some of which often combine in the centre of the sporangium to form a pseudo-columella. Stalk cartilaginous.

KEY TO THE SPECIES OF *CRATERIUM*.

A. Sporangium-wall smooth, glossy; lid distinct:—

Lime-knots white. 1. *C. minutum*

Lime-knots small, yellowish-brown. 2. *C. concinnum*

Lime-knots large and small, reddish-brown. 3. *C. rubronodum*

B. Sporangium-wall mealy, often rugose ; lid less distinct or indefinite :—

Sporangia violet. 4. *C. paraguayense*

Sporangia brown, powdered with white in the upper part. 5. *C. leucocephalum*

Sporangia bright yellow. 6. *C. aureum*

1. **C. minutum** Fries Syst. Myc., iii. 151 (1829) (small). Plasmodium rich yellow. Total height 0·7 to 1·5 mm. Sporangia goblet-shaped, stalked, erect, gregarious, 0·4 to 1·2 mm. high, smooth, pale ochraceous, nut-brown or olive-brown ; lid convex or flat, sometimes depressed, white or concolorous with the sporangium ; sporangium-wall of two layers, the outer cartilaginous, thickened at the rim below the lid, translucent below and continued into the translucent stalk, the inner layer densely charged with white lime-granules ; lime almost absent in the olive-brown form. Stalk cylindrical, plicate, 0·3 to 0·5 mm. long, dark brown, orange-brown or yellowish, rising from a circular hypothallus. Capillitium consisting of slender colourless or yellow threads connecting numerous large white or yellow lime-knots, some of which often combine in the centre to form a pseudo-columella. Spores violet-brown, minutely warted, 8 to 9 μ diam.—Rost. Mon., 120 ; Macbr. N. Am. Slime-Moulds, ed. 2, 107. *Peziza minuta* Leers Fl. Herborn, 277 (1775). *Craterium pedunculatum* Trentep. in Roth Catal. Bot., i. 224 (1797) ; Lister Mycetozoa, 70. *C. vulgare* Ditm. in Sturm Deutsch. Fl., Pilze, i. 17, t. 9 (1813) ; Rost. l.c., 118. *C. pyriforme.* Ditm. l.c., 19, t. 10 ; Rost. l.c., 120. *C. turbinatum* Fr. l.c., 152. *C. nutans* Fr. l.c., 151. *C. Oerstedtii* Rost. l.c., 120 (1875). *C. Friesii* Rost. l.c., 122. *C. confusum* Mass. Mon., 263 (1892). *Cyathus minutus* Hoffm. Veg. Crypt., 6 (1787). *Sphaerocarpus turbinatus* Bull. Champ., 132, t. 484, f. 1 (1791) ? *S. operculata* Schum. Enum. Pl. Saell., ii. 220 (1803) ? *Physarum turbinatum* Schum. l.c., 205. *P. pedunculatum* Schum. l.c.

Pl. 78.—*a, b, c.* sporangia of various shapes (Dorset) ; *d.* capillitium and spores, with a fragment of sporangium-wall ; *e.* spore.

Observations of sporangia from extensive plasmodia in leaf-heaps and in cultures show that the varieties in shape and colour described by Rostafinski under the names of *C. vulgare, C. pyriforme, C. minutum,* and *C. Friesii* may arise from one source, and no specific characters exist to separate the four forms. The type specimen of *C. Oerstedtii* Rost. in the Strasburg Herbarium differs in no character from the present species ; the sporangia are pyriform and yellow-brown ; no lids remain, but they are described as white ; the capillitium resembles that met with in most forms of *C. minutum* ; a distinct pseudo-columella is present. Specimens from America have small sporangia of a dark-olive or greyish-brown colour and

no pseudo-columella developed. The most frequent form in Europe is larger and the sporangia are brighter brown. When weathered they become bleached and white; in abnormal developments they may be sessile or form short plasmodiocarps, but there is usually some differentiation into a lid in the upper part of the sporangium-walls.

Hab. On dead leaves and sticks; common in the British Isles from summer to early spring, and apparently equally abundant in all temperate regions; less common in the tropics.

2. **C. concinnum** Rex in Proc. Acad. Nat. Sc. Phil. (1893), 370 (neat). Plasmodium at first milky, then cream-coloured. Total height 0·5 to 0·7 mm. Sporangia broadly funnel-shaped or goblet-shaped, stalked, 0·2 to 0·5 mm. diam., smooth, pinkish-red or olive-brown, often paler above, opening by a well-defined convex paler lid; sporangium-wall cartilaginous. Stalk red or brown, 0·1 to 0·2 mm. long. Capillitium consisting of numerous small yellowish-brown angular lime-knots, connected by short and sparingly branched hyaline threads, sometimes with a small pseudo-columella. Spores purplish-brown, minutely warted, 8 to 9 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 107.

Pl. 79.—*a*, *b*. sporangia of various shapes (Philadelphia); *c*. capillitium and spores, with fragment of sporangium-wall; *d*. spore.

This species differs from *C. minutum* in the smaller size, the brown lime-knots, and the browner spores. A specimen from Japan, where *C. concinnum* appears to be not uncommon, has nearly sessile and strangely distorted sporangia.

Hab. On bark and moss, or on the burrs and leaves of *Castanea dentata* Borkhausen; recorded from the eastern United States and Japan.

3. **C. rubronodum** G. Lister in Trans. Brit. Myc. Soc., v. 74, Pl. 1, figs. 1, 1*a–d* (1915) (*ruber* red, *nodus* knot). Plasmodium primrose-yellow, then orange. Sporangia gregarious, stalked, goblet- or saucer-shaped, 0·2 to 0·4 mm. high, 0·2 to 0·6 mm. wide, smooth, pearl-grey with a dark red-brown base; lid well defined, convex or nearly flat with an upturned rim, white or pinkish-grey, smooth: sporangium-wall somewhat cartilaginous, pinkish-grey, with uniform deposits of lime-granules, studded on the inner side with many small pouches also containing lime. Stalk dark red-brown, slender, 0·1 to 0·2 mm. high, arising from a discoid hypothallus. Capillitium consisting of ovoid or irregular rounded pale pink lime-knots (dark red-brown by transmitted light) connected by slender hyaline threads, usually with a large central hollow or solid pseudo-columella. Spores purplish-grey, 10 to 12 μ diam., marked with scattered spines whose bases may be connected so as to form a broken reticulation.—*Badhamia rubiginosa* var. *concinna* G. Lister *in litt.*, see Minakata in Bot. Mag. Tokyo, xxvii. 408 (1913).

Pl. 205.—*a*. sporangia; *b*. sporangium with one-half cut away to show the large central ball of lime; *c*. capillitium and spores, with fragment of sporangium-wall; *d*. spores.

Distinguished from *C. concinnum* by the pearl-grey sporangia, red lime-knots and large rough spores.

Hab. Found by Mr. K. Minakata, on dead bamboo leaves and rotting wood on the ground, in company with *C. concinnum*, Tanabe, Kii, Japan, Aug. 1911; found also on dead leaf, Serampore, Bengal, by Mrs. Drake, Jan. 1924.

4. **C. paraguayense** Lister Mycetozoa, ed. 2, 95 (1911) (Paraguay, S. America). Plasmodium ? Sporangia stalked, gregarious, goblet-shaped or cylindrical with a convex apex, erect, 0·7 to 0·8 mm. high, 0·3 to 0·6 mm. broad, rugose, bright reddish-violet reticulated with a paler shade; on maturity the apex falls away as a more or less distinct lid; sporangium-wall cartilaginous, composed of two closely connected layers with deposits of pale violet lime-granules distributed throughout but chiefly concentrated in pouch-like cavities of the wall, giving the effect of pale reticulations to the opaque object. Columella irregular or cylindrical, pale violet, charged with lime throughout. Stalk cylindrical, 0·4 mm. high, 0·07 mm. thick, plicate, purple, opaque, arising from a disc-shaped hypothallus. Capillitium consisting of pale violet threads connecting large violet lime-knots that combine in the centre of the sporangium to form a columella which is either connected with or free from the apex of the stalk. Spores violet, nearly smooth, 8 to 9 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 103. *Didymium paraguayense* Spegaz. in Anal. Soc. Cient. Argent., xxii. 186 (1886); Mass. Mon., 250. *D. guarapiense* (errore) Spegaz. l.c., xxvi. 60. *Craterium rubescens* Rex in Proc. Acad. Nat. Sc. Phil. 1893, 370; Lister Mycetozoa, 71. *Iocraterium rubescens* Jahn in Hedw., xliii. 302, fig. 1 *a-e* (1904). *Iocraterium paraguayense* Torrend Fl. Myx., 174 (1909).

Pl. 80.—*a*. sporangia, from Brazil; *b*. a sporangium with broken walls showing the columella; *c*. capillitium and spores; *d*. sporangia (Paraguay); *e*. capillitium and spores of the same, with fragment of sporangium-walls; *f*. spore.

This species was placed by Dr. Jahn in a new genus, *Iocraterium*, on the ground that the central mass of confluent lime-knots is connected with the apex of the stalk, and thus forms a true columella; but this character does not appear to be constant, and is not evident in the type of *C. rubescens* Rex from Louisiana.

Hab. On dead leaves.—Recorded from Louisiana, Paraguay, and Brazil.

5. **C. leucocephalum** Ditm. in Sturm Deutsch. Fl., Pilze, i. 21, t. 11 (1813) (λευκός white, κεφαλή head). Plasmodium rich yellow. Total height 1 mm. Sporangia ovoid or turbinate, stalked, erect, 0·7 mm. high, 0·4 to 0·6 mm. broad, red-brown with white incrustations of lime, usually spotted with minute yellow warts on the upper half; in abnormal developments plasmodiocarp forms may occur. Lid white, convex. Sporangium-wall thin, consisting of two closely connected layers; the outer yellow, provided in the upper part with scattered

lime-deposits and studded with shallow pouches containing white lime-granules, usually associated with yellow crystalline disc-shaped bodies ; the lower part cartilaginous, translucent, darker ; the inner layer membranous and colourless. Stalk cylindrical, plicate, 0·3 to 0·5 mm. long, red-brown, translucent, cartilaginous, rising from a circular hypothallus. Capillitium consisting of large, irregularly shaped white, yellowish or orange lime-knots, connected by yellow branching hyaline threads, with frequent flattened expansions at the axils, often with a pseudo-columella. Spores violet-brown, minutely warted, 7 to 9 μ diam.—Fr. Syst. Myc., iii. 153; Rost. Mon., 123; Mass. Mon., 267 ; Macbr. N. Am. Slime-Moulds, ed. 2, 105. *Stemonitis leucocephala* Pers. in Gmel. Syst. Nat., 1467 (1791). *S. cyathiformis* Schrank in Roemer & Usteri Mag. Bot., iv. pt. 12, 19 (1790) ? *Peziza convivale* Batsch Elench. Fung., 121 (1783) ? *Arcyria leucocephala* Hoffm. Fl. Crypt. Germ., t. 6 (1795). *Cupularia leucocephala* Link Handb., iii. 421. *Cyathus cinereus* Purton Midl. Fl., iii. 309 (1821). *Physarum leucostictum* Chev. Fl. Paris, 336 (1826) ? *C. xanthopus* Wallr. Fl. Crypt. Germ., ii. 358 (1833). *C. deoperculatum* Fr. in Weinm. Hymen. & Gastrom., 597 (1836). *C. pendulum* Fr. l.c. ? *C. pruinosum* Corda Icon. Fung., v. 13, t. ii, fig. 33 (1854). *C. Fuckelii* Mass. l.c., 272 (1892). *C. convivale* Morg. in Journ. Cinc. Soc. Nat. Hist., xix. 14 (1896).

Var. **cylindricum** Lister Mycetozoa, ed. 2, 97 (1911). Sporangia cylindrical, nearly white with a reddish-brown base, the walls often without crystalline discs.—*C. minimum* Berk. & Curt. in Grev., ii. 67 (1873) ; Mass. Mon., 272. *C. cylindricum* Mass. l.c., 268 (1892) ; Macbr. N. Am. Slime-Moulds, ed. 2, 106.

Var. **scyphoides** Lister l.c. (σκύφος a cup). Sporangia turbinate, greyish-white with a red-brown base, dehiscing irregularly and not by a distinct lid.—*Physarum scyphoides* Cooke & Balf. (in Raven. Fung. Am. Exs., No. 480) ex Mass. in Journ. Myc., v. 186, t. xiv, fig. 7 (1889) ; Mass. Mon., 282.

Var. **inclusum** Čel. fil. Myx. Böhm., 79, Taf. v, figs. 1 to 3 (1893) (enclosed). Similar to var. *scyphoides* but the sporangia are clustered on a common stalk.

Var. **rufum** G. Lister (red). Sporangia obovoid-cylindrical with very short stalks, brownish-red all over, including the well-defined lid.

Pl. 81.—*a*, *b*. sporangia of various shapes; the wall of the middle one in *b*. is broken and shows a pseudo-columella (England) ; *c*. sporangia of var. *cylindricum* (Ceylon) ; *d*. sporangia of var. *scyphoides* (Georgia, U.S.A.) ; *e*. spores and capillitium, with fragment of sporangium-wall showing crystalline discs ; *f*. spore.

In the typical form the yellow crystalline bodies are present in the sporangium-wall, in the lime-knots and columella, and can easily be detected by treating the sporangia with xylol. Those in the wall are usually disc-shaped with a crenate margin, measuring 15 to 40 μ diam. ; those in the lime-knots are somewhat globular, varying from 5 to 20 μ diam., often

clustered ; they dissolve rapidly in dilute carbolic acid. The vars. *cylindricum* and *scyphoides* have the characteristic discs in the lime-knots, but not as a rule in the sporangium-wall. The var. *inclusum*, with its clusters of more or less confluent grey sporangia on a common dark-red stalk, is a curious growth, and is, perhaps, hardly more than a form of var. *scyphoides*. The var. *rufum* was found in large quantities by Mr. K. Minakata in July, 1916, in the province of Erchu, Japan. It resembles var. *cylindricum* in shape ; in the walls are embedded the ' discs ' characteristic of the typical form. The specimen issued by Fuckel as *C. mutabile* Fr., 1455 Fung. Rhen. Exs. (B.M. 481) (type of *C. Fuckelii* Mass.), is a subglobose form of the present species with scarcely any lime in the sporangium-wall ; the spores measure 9 to 10 μ diam., and are minutely warted.

Hab. On dead leaves and twigs.—The typical form is abundant throughout the British Isles and Europe ; it is less common in the United States, and has also been recorded from New Zealand and Bermuda : var. *cylindricum* is the common form in the United States and in the tropics ; it has been gathered repeatedly in Moldavia and Japan : var. *scyphoides* has been recorded from the south of France, the Cape Province, the United States and the Galapagos Islands : var. *inclusum* from Bohemia and North Germany.

6. **C. aureum** Rost. Mon., 124 (1875) (golden). Plasmodium lemon-yellow. Sporangia gregarious, obovoid, ovoid or globose, 0·4 to 0·6 mm. diam., stalked, erect, rugose, golden-yellow or greenish, fading almost to white on exposure, without a definite lid, breaking up at maturity in the upper part into areolae, or dehiscing almost to the base in stellate lobes ; sporangium-wall single, membranous, with deposits of included yellow lime-granules which are denser and of a deeper yellow on the summit, somewhat stouter and more persistent at the base where it is continued into the cartilaginous stalk. Stalk cylindrical, 0·2 to 0·5 mm. long, stout, deeply furrowed, nearly translucent, but charged with lime-granules, orange-red or yellow, arising from a circular hypothallus. Pseudo-columella either absent or represented by a central mass of confluent lime-knots. Capillitium of irregularly shaped yellow lime-knots, varying much in size, connected by a network of hyaline threads with triangular expansions at the axils of the branches. Spores violet-brown, spinulose, 8 to 9, rarely 10 μ diam.—Mass. Mon., 269 ; Macbr. N. Am. Slime-Moulds, ed. 2, 104. *Trichia aurea* Schum. Enum. Pl. Saell., ii. 208 (1803). *Craterium mutabile* Fr. Syst. Myc., iii. 154 (1829) (*non* Symb. Gast.) ; Wallr. Fl. Crypt. Germ., ii. 357 ; Lister Mycetozoa, 73.

Pl. 67.—*a*. sporangia (Devon) ; *b*. capillitium and spores, with fragment of sporangium-wall ; *c*. spore.

This species holds an intermediate position between the genera *Physarum* and *Craterium* ; it is retained somewhat doubtfully in the present genus on account of the usually ovoid sporangia having the wall cartilaginous at the base, and from its general resemblance to *C. leucocephalum*. It is allied to *P. citrinellum* Peck, and differs in the shape of the sporangia, in the orange-yellow stalks, and in the smaller spores. It also closely resembles *Badhamia viridescens* Meylan, q.v. A specimen gathered by Mr. W. G.

Freeman, on leaves, at Onitcha Olona, South Nigeria, in 1904 (B.M. 2372), is probably a form of the present species, though in the structure of the stalk it shows affinities with *P. sulphureum*; the sulphur-yellow obovoid sporangia tend to expand on maturity in a stellate manner, and have a columella which in some cases is attached to the apex of the stalk, and in others is free; the spores measure 7 to 8 μ; the stalks are nearly white, and are brittle from dense deposits of enclosed white lime-granules.

Hab. On dead leaves.—Not uncommon throughout the British Isles; recorded from France, Denmark, Sweden, Germany, Moldavia, Portugal, Algeria, Nigeria, Cape Province, Ceylon, and Japan; in the United States from New Jersey, New York, Pennsylvania, North Carolina, Ohio, Iowa and Colorado.

Genus 10.—**LEOCARPUS** Link in Mag. Ges. Nat. Fr. Berl., iii. 25 (1809) (λεῖος smooth, δέρμα skin). Sporangium-wall of two layers, the outer cartilaginous, shining, with deposits of lime on the inner side, the inner hyaline. Capillitium consisting of a network of rigid hyaline threads, with branched anastomosing brownish lime-knots.

1. **L. fragilis** Rost. Mon., 132, fig. 93 (1875). Plasmodium lemon-, then orange-yellow. Sporangia clustered, obovoid or globose, sessile or shortly stalked, 2 to 4 mm. long, smooth, yellowish-brown, chestnut or purple-brown, rarely ochraceous, shining, sometimes dehiscing in revolute floriform lobes; the outer layer of the sporangium-wall cartilaginous, brittle, orange-brown by transmitted light, usually with dense deposits of lime-granules on the inner side; the inner layer a firm hyaline membrane, giving attachment to the capillitium. Stalk short, weak, yellowish, translucent, arising from a membranous hypothallus. Capillitium a network of rigid hyaline threads with flattened expansions at the axils, connected with angular branching and anastomising brown lime-knots. Spores spinulose, 9 to 13 μ diam., occasionally 15 to 20 μ diam., sometimes slightly clustered, purplish-brown or dark brown, with a pale spot where dehiscence occurs.—Mass. Mon., 338; Macbr. N. Am. Slime-Moulds, ed. 2, 112. *Lycoperdon fragile* Dicks. Pl. Crypt. Brit., i. 25, t. iii, fig. 5 (1785). *Reticularia fragilis* Poir. in Lam. Encycl., vi. 183 (1804). *Diderma vernicosum* Pers. in Usteri Ann. Bot., xv. 34 (1795). *D. atrovirens* Fr. Syst. Myc., iii. 103 (1829). *D. ramosum* Fr. l.c., 105. *Lycogala parasiticum*, Withering Br. Pl., ed. 4, iv. 372 (1801). *Trichia lutea* Trent. in Roth Catal. Bot., i. 230 (1797). *Physarum nitidum* Schum. Enum. Pl. Saell., ii. 205 (1803). *P. vernicosum* Schum. l.c., 206. *Spumaria ramosa* Schum. l.c., 195. *Leocarpus vernicosus* Link l.c.; Lister Mycetozoa, 75. *L. spermoides* Link l.c. *L. atrovirens* Fr. Symb. Gast., 13 (1817). *L. ramosus* Fr. Summ. Veg. Scand., 450 (1849). *Leangium atrovirens* Fr. Stirp. Femsj., 83 (1827). *L. vernicosum* Fr. l.c. *Tripotrichia elegans* Corda

Icon. Fung., i. 22, t. vi. fig. 288 *a* (1837). *Liceopsis jurana* Meylan in Bull. Soc. Vaud. Sc. Nat., liii. 459 (1921).

Pl. 81.—*a*. sporangia (England); *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

The plasmodia of this species are often large, and when about to change into fruit may creep for a considerable distance from their feeding grounds; sporangia have been found in one instance some feet up the trunk of a larch tree, and on another occasion among the upper branches of a small furze bush. Although abundant in temperate regions it is rarely met with in the tropics. *Liceopsis jurana* Meylan appears to be an irregular limeless development of the present species, judging from a mounting courteously sent by M. Meylan. The sessile clustered shining golden-brown sporangia developed from yellow-green plasmodium on a lichen, at Granges de Ste. Croix, Jura, July 1920. The sporangium-wall is like that of *Leocarpus*; the capillitium consists of irregular branching strands, partly orange and cartilaginous, partly purplish and membranous; the spores are ill developed and vary from 9 to 20 μ diam.; they are purplish-brown and closely spinulose.

Hab. On dead leaves, twigs, &c.: common in the British Isles in summer and autumn, and widely distributed throughout Europe; recorded also from the Cape Province, from near Simla (North-West India), East Tibet, Tasmania, New South Wales, South Australia, New Granada, Chili, and in many of the United States.

Genus 11.—**DIDERMA** Persoon in Roemer N. Mag. Bot., i. 89 (1794) (δίς double, δέρμα skin). Sporangia stalked, sessile, or forming plasmodiocarps; sporangium-wall of two layers (single in *D. simplex*), containing deposits of lime in granules (in crystalline nodules in *D. Trevelyani*). Columella usually present. Capillitium threads simple or branched, without lime-knots.

KEY TO THE SPECIES OF *DIDERMA*.

Subgenus 1. EUDIDERMA. Outer sporangium-wall a smooth crust composed of lime-granules densely compacted (wall single in *D. simplex*); inner layer membranous.

A. Spores reticulated. 1. *D. subdictyospermum*

B. Spores not reticulated—

a. Sporangia white or nearly so—

Sporangia globose, stalked. 2. *D. montanum*

Sporangia disc-shaped, stalked. 3. *D. hemisphericum*

Sporangia sessile, discoid or forming plasmodiocarps; columella brownish flesh-colour; spores 6–9 μ. 4. *D. effusum*

Similar to No. 4, but sporangia scattered and spores 10–15 μ. 5. *D. arboreum*

Sporangia crowded, hemispherical; columella white, convex; layers of sporangium-walls combined; spores violet-brown, 7–10 μ. 6. *D. spumarioides*

Sporangia crowded, subglobose; columella small, convex, white; outer sporangium-wall shell-like, separating from the persistent colourless inner wall; spores purplish-brown, 10–14 μ. 7. *D. globosum*

Sporangia crowded, usually forming plasmodiocarps, with a shell-like outer wall; columella convex, flesh-coloured. 8. *D. alpinum*

Sporangia subglobose, crowded, inner wall orange below; columella subglobose or hemispherical, orange or flesh-coloured; spores 9–12 μ, spinulose. 9. *D. niveum*

Sporangia subglobose or obovoid; columella subglobose or clavate, flesh-coloured; spores coarsely warted, 11–15 μ. 10. *D. Lyallii*

Plasmodiocarps scattered, curved or ring-shaped, with the inner wall orange; columella none. 11. *D. deplanatum*

b. Sporangia flesh-coloured, depressed. 12. *D. testaceum*

c. Sporangia reddish clay-coloured or brownish buff, rarely yellow; walls ingle. 13. *D. simplex*

Subgenus 2.—LEANGIUM: sporangium-wall cartilaginous.

A. Sporangium-wall brown externally; lime in crystalline nodules; columella often absent. 16. *D. Trevelyani*

B. Sporangium-wall without a crystalline layer—

a. Spores with widely scattered warts; sporangia stalked. 17. *D. floriforme*

b. Spores closely spinulose or nearly smooth—

Sporangia pinkish or red-brown, sessile, hemispherical; columella indefinite; capillitium usually colourless. 14. *D. Sauteri*

Sporangia ochraceous, sessile, subglobose or ring-shaped; columella indefinite; capillitium purple-brown. 15. *D. ochraceum*

Sporangia grey or brown; columella pale, hemispherical; stalk stout, ochraceous. 18. *D. radiatum*

Sporangia mottled, brown; columella convex, ochraceous; stalk short, black. 19. *D. roanense*

Sporangia brown, marked with close radiating dark lines, usually sessile, hemispherical; columella white, convex. 20. *D. asteroides*

Sporangia sessile, crowded, red-brown; columella rough. 21. *D. antarctica*

Sporangia and clavate columella white; stalk slender, black, rarely none. 22. *D. rugosum*

Sporangia orange-red; columella clavate or globose; stalk dark brown. 23. *D. lucidum*

Subgenus 1.—Eudiderma. Sporangia sessile (or stalked in Nos. 2 and 10); sporangium-wall dehiscing irregularly, consisting of two layers (single in No. 13), the outer layer a smooth crust of globular lime-granules, the inner layer membranous.

1. **D. subdictyospermum** Lister Mycetozoa, ed. 2, 101 (1911) (*sub* somewhat, δίκτυον net, σπέρμα seed). Plasmodium ? Sporangia crowded, subglobose or hemispherical, sessile, 0·3 to 0·5 mm. diam., snow-white, seated on a well-developed white hypothallus; sporangium-wall thick, fragile, composed of a smooth outer crust of lime-granules closely adhering to the delicate membranous inner layer. Columella hemispherical or subglobose, white. Capillitium consisting of somewhat rigid purplish sparingly-branched threads, anastomosing near the extremities. Spores 10 to 12 μ diam., purplish-brown, reticulated with raised ridges or with broken bands forming a border about 2 μ broad.—*Chondrioderma subdictyospermum* Rost. Mon., App. 16 (1876); Lister Mycetozoa, 77; Penzig Myx. Buit., 44. *C. dealbatum* Mass. Mon., 207 (1892).

Pl. 87.—*d*. sporangia (Venezuela); *e*. capillitium and spores; *f*. spores.

This species forms large colonies covering an area of one or two square inches. It is allied to *D. spumarioides*, but differs essentially in the reticulated spores. The type from Venezuela (B.M. 570), marked in Berkeley's herbarium '*Didymium dealbatum* B. & C.' remained undescribed until Rostafinski published it as *Chondrioderma subdictyospermum*; in this specimen the spores are marked with ridges more or less combined into an incomplete net. In other gatherings the spores are regularly reticulated with raised bands.

Hab. On dead leaves and moss.—Ceylon, Java, Venezuela.

2. **D. montanum** Meylan in Bull. Soc. Vaud. Sc. Nat., liii. 454 (1921) (on mountains). Plasmodium white or pale yellow ? Sporangia scattered or in groups, stalked, subglobose, flattened or umbilicate beneath, pearl- or pinkish-grey or nearly white, smooth or somewhat wrinkled, 0·6 to 0·8 mm. diam.; sporangium-wall of two often separating layers, the outer densely charged with lime-granules, the inner membranous, reddish-brown throughout or towards the base. Stalk pale or bright yellow-brown, slender or stout, enclosing

white lime deposits, 0·1 to 0·8 mm. high. Columella hemispherical or more usually globose, small, brownish-red, sometimes stalked. Capillitium consisting of slender purplish or hyaline threads, branched and anastomosing towards the extremities. Spores pale brownish-purple, faintly spinulose, 8 to 10 μ diam.—*D. cor-rubrum* Macbr. N. Am. Slime-Moulds, ed. 2, 140 (1922). *Chondrioderma montanum* Meylan in Bull. Soc. Bot. Genève, sér. 2, ii. 262 (1910).

Var. **album** G. Lister (white). Sporangia white or bluish-white, stalks and columellae white or cream-white ; capillitium colourless.—*Chondrioderma radiatum* var. *album* Torrend Fl. Myx., 168 (1909).

Var. **roseum** Meylan in Bull. Soc. Vaud. Sc. Nat., lii. 450 (1919). Plasmodium red ; sporangia and stalks pale pink ; columella dull pink.

Pl. 207.—*a*. sporangia, two of which are broken and show the membranous inner wall ; *b*. capillitium and spores with fragment of sporangium-wall ; *c*. spore.

This species is closely allied to *D. radiatum* var. *umbilicatum*, under which it was included until M. Meylan recognized its claims to specific rank. It is distinguished by the sporangium-wall consisting of two layers, and by the spores being paler, smoother and smaller. *D. cor-rubrum*, a specimen of which from Iowa has courteously been sent us by Prof. Macbride, is a form of the present species with white wrinkled sporangium-wall and stalk, and dark red columella and inner sporangium-wall ; in some of the sporangia a few spike-like processes connect the walls with the columella, such as occur sometimes in *D. radiatum* and other species of the genus when conditions of development have not been perfect.

Hab. On dead leaves, moss and twigs : apparently not unfrequent in the British Isles ; recorded from Essex, Surrey, Devon, and Salop ; also from North Germany, Norway, Switzerland, Moldavia, and Iowa : var. *album* from Dorset, France, and Portugal : var. *roseum* has been obtained once in the Jura Mountains.

3. **D. hemisphericum** Hornem. Fl. Dan., xxxiii. 13 (1829). Plasmodium opaque white. Sporangia scattered, flat, disc-shaped on a central stalk, 1 to 1·25 mm. diam., rarely sessile and confluent, chalk-white ; sporangium-wall of two layers on the flat upper surface, the outer a smooth crust composed of globular lime-granules 1 to 3 μ diam., easily separating and breaking away from a more persistent membranous inner layer ; under surface rugose, thickened. Stalk ochraceous or brownish, 0·2 to 0·8 mm. long, 0·25 mm. thick, furrowed with wrinkles which are continued over the flat under side of the sporangium, densely calcareous, often seated on a white hypothallus. Columella consisting of the broad thickened base of the sporangium, flesh-red or flesh-brown, charged with calcareous deposits usually in the form of nodules and large rhomboidal crystals. Capillitium consisting of slender colourless threads, branched and anastomosing, or of violet-brown threads 1 to 2 μ thick, sparingly branched except at the pale extremities. Spores pale violet-brown, almost smooth, 7 to

9 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 138. *Reticularia hemispherica* Bull. Champ., 93, t. 446, fig. 1 (1791), in part; Sow. Engl. Fung., t. 12. *R. contorta* Poiret in Lam. Encycl., vi. 182 (1804). *Physarum depressum* Schum. Enum. Pl. Saell., ii. 202 (1803). *P. Michelii* Corda Icon. Fung., v. 57, tab. iii, fig. 33 (1842). *Didymium hemisphericum* Fr. Syst. Myc., iii. 115 (1829), in part. *D. Michelii* Lib. Pl. Arduen. Exsic., fasc. ii. no. 180 (1832). *Diderma depressum* Fr. l.c., 108 ? *D. Michelii* Morgan in Journ. Cinc. Soc. N. H., xvi. 153 (1894). *Chondrioderma Michelii* Rost. in Fuckel Symb. Myc., Nachtr., ii. 74 (1873); Rost. Mon., 172; Mass. Mon., 204; Lister Mycetozoa, 79. *C. Friesianum* Rost. l.c., 172 ? *C. hemisphericum* Torrend Fl. Myx., 163 (1909).

Pl. 83.—*a*. sporangia (England); *b*. capillitium with fragment of sporangium-wall and spores; *c*. capillitium of stouter form; *d*. nodules of lime from the stalk; *e*. spore.

This species may usually be distinguished from *Diderma effusum* by the larger discoid sporangia having pale stalks, which are rarely entirely absent in any development. *D. depressum* Fr. is described as having regular orbicular sessile sporangia with a thick white fugaceous outer peridium; it was probably a sessile form of the present species, or possibly *D. effusum*.

Hab. On dead leaves and twigs: not uncommon in England and Scotland throughout the year; widely distributed throughout Europe, the United States and the tropics; recorded from Algeria, Cape Province, and Japan.

4. **D. effusum** Morg. in Journ. Cinc. Soc. Nat. Hist., xvi. 155 (1894) (*non* Link) (poured out). Plasmodium white. Sporangia sessile, gregarious or crowded, depressed, smooth, white or pale drab, either rounded, 0·7 mm. diam., or forming elongated and flat, simple or branching net-like or effused plasmodiocarps, sometimes 6 cm. long and 1 cm. or more broad; sporangium-wall of two layers, the outer a fragile crust of globular lime-granules, separating from the membranous colourless inner wall. Columella pulvinate, depressed, brownish flesh-coloured, enclosing white lime-granules. Capillitium consisting of delicate colourless or pale purplish threads, sparingly branched and anastomosing. Spores pale violet-brown, nearly smooth, 6 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 130. *Physarum effusum* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 257 (1832). *P. crustiforme* Speg. in An. Mus. Nac. Buen. Airos, vi. 200 (1898–9). *Didymium reticulatum* Rost. in Fuckel Symb. Myc., Nachtr., ii. 73 (1873). *Chondrioderma reticulatum* Rost. Mon., 170 (1875); Mass. Mon., 216; Lister Mycetozoa, 79; Petch in Ann. Perad., iv. 344. *C. Saundersii* Berk. & Br. in litt.; Mass. Mon., 209 (1892). *Diderma reticulatum* Morg. l.c., 155; Macbr. l.c., ed. 1, 95.

Pl. 83.—*f*. orbicular and plasmodiocarp forms of sporangia (Philadelphia).

The name *Diderma effusum* was adopted by Morgan for this species after it had been shown by Dr. Rex to be similar to the Schweinitzian type of

Physarum effusum. Morgan's graphic description leaves no doubt that his specimens were the reticulate and effused form of the present species, which had been distributed under the name *Chondrioderma reticulatum* Rost. *Diderma effusum* is closely allied both to *D. hemisphericum* (q.v.) and to *D. testaceum*; from the latter it is distinguished by the more frequent plasmodiocarp habit, the flatter sporangia and the absence of any rosy tinge in the sporangium-wall and columella. Ceylon gatherings, marked '75. *Diderma depressum* Fr.' (B.M. 514; K. 1438, 1439), showing flattened white plasmodiocarps with brownish flesh-coloured columella, must be referred to the present species; so also must the type of *Chondrioderma Saundersii* Berk. & Br. from Java (B.M. 1962), in which the flat plasmodiocarps are effused over the under side of pinnules of a species of *Adiantum*.

Hab. On dead leaves and twigs: not unfrequent in the British Isles in summer and autumn; widely distributed in temperate and tropical regions.

5. **D. arboreum** G. Lister & Petch in Journ. Bot., li. 2, t. 524, f. 2 (1913) (arboreal). Plasmodium ? Sporangia scattered, discoid, sessile, rarely stalked, 0·5 to 0·7 mm. diam., or forming expanded and lobed, flattened plasmodiocarps 1 to 3 mm. diam., white, or purplish-grey from absence of lime-deposits; sporangium-wall membranous, with deposits of round or angular lime-granules either united to form a thin crust or sparsely distributed, often with scattered deposits of refuse matter. Stalk when present very short, dark brown. Columella low, convex, flesh-coloured, or reduced to a slight thickening of the sporangium-floor, with deposits of lime in the form of granules or small nodules, often mixed with refuse matter. Capillitium consisting of simple or branching and anastomosing colourless or purplish rather stout threads, often with membranous expansions at the axils. Spores very minutely and closely spinulose, pale purplish-grey, 10 to 15 μ diam.—*Chondrioderma Alexandrowiczii* Rost. Mon., 169 (1875) ?

Pl. 206.—*a*. Two discoid sporangia and a plasmodiocarp; *b*. spores and capillitium; showing attachment of threads to upper and lower sporangium-walls; *c*. irregular capillitiums; *d*. spore.

This inconspicuous species is probably often overlooked from the scattered sporangia appearing on moss and lichen on the bark of living trees; it has been noted by the Rev. W. Cran near Aberdeen and by Mr. K. Minakata in late summer and autumn in most years since 1910, and may be not uncommon. It is distinguished from *D. effusum* by the larger spores and coarser often irregular capillitium. The calcareous deposits are sometimes in the form of small irregular crystals instead of round granules, when the species defies the characters distinguishing the genus *Diderma* from *Didymium*. It is probable that the type of *Chondrioderma Alexandrowiczii* Rost., syn. *Didymium chondrioderma* de Bary & Rost. in Alex. Stroj. &c., 89 (1872), found on alder bark at Bielany, Poland, by Prof. Alexandrowicz, was the present species.

Hab. On moss, lichen and bark, on the trunks of living trees: recorded from Cornwall, Aberdeenshire, Moldavia, Ceylon, Malaya, and Japan.

6. **D. spumarioides** Fries Syst. Myc., iii. 104 (1829) (*Spumaria*, synonym for genus *Mucilago*). Plasmodium opaque white. Sporangia crowded, forming large colonies, globose, sessile, 0·5 to 1 mm. diam., smooth or rugose, white; often seated

on a strongly developed white hypothallus ; sporangium-wall of two layers, the outer thick, fragile, composed of globular lime-granules 1 to 2 μ diam., more or less adhering to the membranous inner layer. Columella convex or hemispherical, white or pale flesh-coloured. Capillitium consisting of slender flexuose purplish threads, branching at an acute angle and anastomosing. Spores violet-brown, spinulose, 8 to 11 μ diam. —Morgan in Journ. Cinc. Soc. Nat. Hist., xvi. 151 ; Macbr. N. Am. Slime-Moulds, ed. 2, 132. *Didymium spumarioides* Fr. Symb. Gast., 20 (1818) ; Mass. Mon., 232. *Reticularia sphaeroidalis* Bull. Champ., 94, t. 446, fig. 2 (1791) ? *Spumaria physaroides* Pers. Syn. Fung., 163 (1801) ? *Physarum sphaeroidale* Chev. Fl. Paris, i. 339 (1826) ? *P. stromateum* Link Handb., iii. 409 (1833). *Carcerina spumarioides* Fr. Summ. Veg. Scand., 451 (1849). *Chondrioderma spumarioides* Rost. Mon., 174 (1875) ; Lister Mycetozoa, 76. *C. stromateum* Rost. l.c., App. 18 (1876). *C. virgineum* Mass. l.c., 207 (1892). *Diderma cinereum* Morg. l.c., 154 (1894) ; Macbr. l.c., 138. *D. stromateum* Morg. l.c., 152 (1894).

Pl. 84.—*a*. sporangia (England) ; *b*. capillitium and spores with fragment of sporangium-wall ; *c*. spore.

This species is closely allied to *D. globosum* with which it is connected by intermediate forms ; it differs in having the layers of the sporangium-wall more closely connected and in the smaller smoother spores. The latter, being a microscopic character, could not be observed by the earlier authors, who probably confused the two species. The type of *C. virgineum* Mass. from Hampstead (K. 560) is a form of *D. spumarioides* without hypothallus ; the capillitium in some sporangia is normal, in others there are the expansions described by Massee. The type of *C. stromateum* Rost., from Lochem (*leg.* Spree, Rab. Fung. Eur., no. 432, B.M. 515), does not present any character by which it can be separated from the present species. In gatherings made by Mr. Petch in Ceylon the mature sporangia have their walls cracked into concave polygonal areolæ, whose edges form polygonal ridges (see Petch in Ann. Perad., iv. 343) ; a similar mode of dehiscence occurs in a gathering made by Mr. A. F. Blakeslee in Venezuela (B.M. 2391) ; in other respects these specimens are typical of the present species.

Hab. On dead leaves : abundant in the British Isles and, apparently, throughout Europe, the United States and the southern region of Canada ; widely distributed elsewhere, being recorded from Ceylon, Japan, the West Indies, Bermuda, and South Chili.

7. **D. globosum** Pers. in Roemer N. Mag. Bot., i. 89, t. iv, figs. 4, 5 (1794). Plasmodium white. Sporangia subglobose, sessile, crowded and often forming large colonies, 0·5 to 0·8 mm. diam., rarely forming plasmodiocarps, smooth, white or cream-coloured ; usually seated on a strongly developed white or cream-coloured hypothallus ; sporangium-wall of two layers, the outer eggshell-like, composed of globular lime-granules 1 to 2 μ diam., often separating widely from the membranous inner layer. Columella hemispherical or subglobose, usually minute, white or pale flesh-coloured.

Capillitium consisting of slender irregularly branched and anastomosing pale purplish threads, often with irregular expansions towards the base enclosing a few lime-granules. Spores dark purplish-brown, spinulose, 10 to 14 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 134. *D. crustaceum* Peck in Rep. N. York Mus., xxvi. 74 (1874); Macbride l.c., 135. *Didymium candidum* Schrad. Nov. Pl. Gen., 25 (1797)? *D. globosum* Chev. Fl. Paris, i. 334 (1826)? *Reticularia globosa* Poiret in Lam. Encycl., vi. 182 (1804). *Cionium globosum* Spreng. Syst. Orb. Veg., iv. 529 (1827). *Chondrioderma globosum* Rost. Mon., 180 (1875); Mass. Mon., 206; Lister Mycetozoa, 78. *C. affine* Rost. Mon. l.c., 18 (1876); Mass. l.c., 210. *C. similans* Rost. l.c., 20; Mass. l.c., 209. *C. crustaceum* Berlese in Sacc. Syll., vii. 373 (1888); Mass. l.c., 215. *C. frustulosum* Pat. in Bull. Herb. Boiss., iii. 61 (1895)?

Pl. 85.—*a*. sporangia seated on a stout hypothallus (Poland); *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

Rostafinski describes the spores of *Chondrioderma globosum* as 'pale violet, 8 μ diam.', but the specimen from Warsaw in the Strasburg Herbarium marked with this name in his handwriting (referred to Rost. Mon., 180) has dark rough spores, 11 to 13 μ diam. Whether Rostafinski had seen other specimens corresponding with his description remains uncertain; such forms have been occasionally met with in the United States (Macbr. l.c., 98), and appear to lie on the border line between *D. globosum* and *D. spumarioides*. The type of *C. affine* Rost., also from Warsaw, is similar in all respects to the Warsaw gathering of *D. globosum* above referred to.

Hab. On dead leaves and twigs: recorded in the British Isles from Norfolk, Wiltshire, and North Wales; widely distributed in Europe, frequent in the United States; recorded also from British Columbia.

8. **D. alpinum** Meylan in Bull. Soc. Vaud. Sc. Nat., li. 261 (1917). Plasmodium white. Sporangia crowded, hemispherical, sessile, 0·7 to 1 mm. diam., or usually forming more or less elongated plasmodiocarps, seated on a white hypothallus; outer layer of the wall smooth, eggshell-like, the inner membranous, flesh-coloured. Columella convex, often rugged, ochraceous flesh-coloured. Capillitium consisting of rather stout colourless or purplish threads, branched and anastomosing, straight or flexuose. Spores brownish-purple, distinctly spinulose, 10 to 12 μ diam.—*D. globosum* var. *alpinum* Meylan in Ann. Conserv. Bot. Genève (1913), 310.

Although closely allied to *D. globosum*, this alpine species is found to differ constantly in the plasmodiocarp habit and in the warm-ochraceous colour of the inner wall and columella. The hypothallus is usually well developed, and contains deposits of lime in the form of small round granules or of coarse crystalline nodules.

Hab. On turf or herbaceous stems near melting snow: abundant in spring on the Swiss alps.

9. **D. niveum** Macbr. N. Am. Slime-Moulds, 100 (1899) (belonging to snow). Plasmodium white. Sporangia crowded,

subglobose, or hemispherical, sessile, 0·7 to 1·8 mm. diam., smooth, white, sometimes seated on a white hypothallus; sporangium-wall of two layers, the outer densely charged with white lime-granules, separating from the more persistent inner layer, which is membranous and often iridescent and veined with scanty deposits of lime above, cartilaginous and orange below. Columella broad, convex, or hemispherical, orange or buff. Capillitium of branching and anastomosing rather stout purple threads with pale extremities, sometimes intermixed with more delicate threads, often beaded with wart-like thickenings. Spores purple-brown, minutely spinulose, 9 to 13 μ diam.—*Chondrioderma niveum* Rost. Mon., 170 (1875); Mass. Mon., 206; Lister Mycetozoa, 80. *C. physaroides* Rost. l.c.; Mass. l.c., 214. *C. albescens* Mass. l.c., 209 (1892). *Diderma albescens* Phill. in Grev., v. 114 (1877).

Pl. 89.—*a*. sporangia (Vosges); *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

This species is extremely abundant in the spring in alpine situations, forming conspicuous white colonies on turf, dwarf willows or stones along the edge of patches of melting snow, and it is beneath the snow that the plasmodium creeps and feeds. Sometimes the outer calcareous layer is absent in some sporangia of a colony, when instead of being white they are dark glossy brown. In such forms the usual straight capillitium threads may be represented in part or entirely by a close network of almost colourless threads, with wide membranous expansions in all the axils; similar abnormal capillitium occurs in *Lepidoderma Carestianum* var. *granuliferum* and *Lamproderma atrosporum* var. *debile*. The type of *Chondrioderma physaroides* Rost. gathered by A. de Candolle 'on mountain land, close to perpetual snow', is now in the Geneva Museum; it is the typical form of the present species; so also is *Diderma albescens* Phill., gathered by Harkness on the Blue Cañon, California. Stout forms of *D. niveum* seem to merge into *D. Lyallii*, but the former can usually be distinguished by the deep orange inner sporangium-wall and by the spores being rather smaller and less coarsely warted.

Hab. On turf, twigs, &c., in alpine regions.—Norway, Sweden, Germany, Tyrol, Switzerland, France, California.

10. **D. Lyallii** Macbr. N. Am. Slime-Moulds, 99 (1899) (Dr. Lyall). Plasmodium white. Sporangia crowded, subglobose or obliquely ovoid, sessile or shortly stalked, 1 to 1·5 mm. diam., white, cream-white or mottled with flesh-coloured spots, smooth or somewhat wrinkled, usually seated on an abundant white hypothallus; sporangium-wall of two layers, the outer with dense calcareous deposits, separating from the membranous inner layer, which has scanty deposits of lime-granules and is pinkish flesh-coloured. Stalk short, stout, furrowed, white or ochraceous. Columella hemispherical, globose, clavate or ligulate, cream-white or flesh-coloured. Capillitium consisting of dark purple or colourless, straight or flexuose threads, branching and anastomosing. Spores dark brownish-purple rather coarsely warted, 10 to 15 μ diam.

—*D. niveum* Rost. var. *Lyallii* Lister Mycetozoa, ed. 2, 105 (1911); R. E. Fries in Svensk Bot. Tidskr., vi. 750. *Chondrioderma fallax* Rost. Mon., 171 (1875)? *C. Lyallii* Mass. Mon., 201 (1892); Lister l.c., ed. 1, 81.

Pl. 90.—*a*. sporangia (Switzerland); *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

The type of this species from Fort Colville in the Rocky Mountains, Washington Territory, was collected by Dr. Lyall, surgeon to the Oregon Boundary Commission in 1861 and is in the Kew Herbarium. Since that date it is found that *D. Lyallii* is widely distributed and not uncommon in alpine regions. It occurs on recently exposed turf close to melting snow, and is often associated with *D. niveum* and *Lepidoderma Carestianum*. Early in the season, masses of the grey convoluted sclerotium, an inch or more in diameter, looking like small worm-casts, and belonging apparently to the present species, may be seen lying loose about the turf; the walls of the sclerotium are almost black, but are powdered with glassy calcareous scales, which produce a general grey effect. Occasionally the lime-granules in the sporangium-wall are replaced by crystalline plates, which give a grey colour to the sporangia. The type of *Chondrioderma fallax* Rost. from the Tyrol is not in the Strasburg collection but from Rostafinski's description it may have been the present species.

Hab. On turf near snow in alpine regions.—Sweden, France, Switzerland, Tyrol, mountains of the west Pacific region, South Chili.

11. **D. deplanatum** Fries Syst. Myc., iii. 110 (1829) (level). Plasmodium white. Sporangia scattered or in small groups, pulvinate, sessile, 1 mm. diam., often forming curved or ring-shaped plasmodiocarps, white or cream-coloured; outer sporangium-wall a smooth rather thick brittle crust of lime-granules; inner wall membranous, iridescent, deep orange below. Columella hardly developed or broadly convex, orange. Capillitium consisting of dark purplish simple and branched often warted threads. Spores purplish-brown, minutely spinulose, 9 to 10 μ. *D. niveum* var. *deplanatum* Lister Mycetozoa, ed. 2, 105 (1911). *D. contortum* Hoffm., Fl. Crypt. Germ., iii, tab. 9, fig. 2*a* (1795)? *Leocarpus deplanatus* Fr. Summ. Veg. Scand., 450 (1849). *Chondrioderma deplanatum* Rost. Mon., App. 17 (1876) in part. *C. mutabile* Schroeter in Cohn Krypt. Fl. Schles., iii, pt. 1, 123 (1885)?

Pl. 89.—*d*. ring-shaped plasmodiocarp, the sporangium-wall partly broken away; *c*. spore.

This form, placed as a variety of *D. niveum* in the previous editions of the present work, proves to be a constant species, distinguished by the scattered plasmodiocarp habit and the absence of columella. The specimen in Berkeley's collection from Linlithgow named by him *Diderma cyanescens* Fr., and by Rostafinski *Chondrioderma niveum* (K. 1435), is *D. deplanatum*, having the lower part of the inner wall and flat base orange. *D. contortum* Hoffm. is cited by Fries as a synonym for *D. deplanatum*, but it is somewhat doubtful from the figure and description if they refer to the present species or to a nearly sessile form of *D. hemisphericum*.

Hab. On dead leaves and twigs: frequent in Great Britain; recorded also from the west of Ireland, Denmark, Sweden, Germany, and Portugal.

12. **D. testaceum** Pers. Syn. Fung., 167 (1801) (of tiles, from the reddish sporangia). Plasmodium yellowish-buff (*fide* Torrend). Sporangia sessile, subglobose, depressed on a broad base, sometimes confluent, 0·8 mm. diam., smooth, dull flesh-coloured or pale pinkish, often becoming bleached; sporangium-wall of two layers, the outer thin, brittle, eggshell-like, composed of globular lime-granules, separating freely from the more persistent pinkish-grey membranous inner layer. Columella large, convex or hemispherical, together with the base of the sporangium flesh-coloured or reddish-brown. Capillitium consisting of delicate pale purplish branching flexuose threads. Spores pale violet-brown, almost smooth, 7 to 10 μ diam.—Fr. Syst. Myc., iii. 107; Macbr. N. Am. Slime-Moulds, ed. 2, 137. *Didymium testaceum* Schrad. Nov. Pl. Gen., 25, tab. v, figs. 1, 2 (1797). *Diderma cubense* Berk. & Curt. in Journ. Linn. Soc., x. 347 (1869). *D. Mariae-Wilsoni* Clinton in Rep. N. York Mus., xxvi. 74 (1874). *D. sublateritium* Berk. & Br. in Journ. Linn. Soc., xiv. 82 (1873). *Cionium testaceum* Spreng. Syst. Veg., iv. 529 (1827). *Chondrioderma testaceum* Rost. Versuch, 13 (1873); Rost. Mon., 179; Mass. Mon., 210; Lister Mycetozoa, 78. *C. sublateritium* Rost. l.c., App. 19 (1876); Mass. l.c., 211. *C. cubense* Rost. l.c.

Pl. 87.—*a*. sporangia (Poland); *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

The type of *Diderma sublateritium* Berk. & Br., from Ceylon (K. 1454), is more rufous in colour than is usual in the present species, though not so deep in tone as a specimen from South Carolina (B.M. 520); the capillitium and spores are typical of *D. testaceum* of which it is clearly a form.

Hab. On dead leaves and twigs, appearing in summer and autumn in England: not common; recorded from Devon, Wiltshire, Worcestershire, Hertfordshire, Bedfordshire, and Norfolk; in Europe recorded from France, Germany, Poland, Moldavia, and Portugal; also from Ceylon, Japan, and the West Indies; in the United States it is widely distributed from east to west.

13. **D. simplex** Lister Mycetozoa, ed. 2, 107 (1911) (simple). Plasmodium orange-brown. Sporangia crowded or somewhat scattered, sessile, subglobose, hemispherical and often depressed, 0·3 to 0·7 mm. diam., or forming short curved plasmodiocarps, smooth or rugulose, ochraceous, reddish clay-coloured or bright chocolate-brown, sometimes seated on a well-developed hypothallus; sporangium-wall single, membranous, with abundant deposits of coloured lime-granules. Columella indefinite and rugose, or convex. Capillitium consisting of slender colourless or dark branching threads, often with expansions at the base containing lime-granules. Spores brownish-violet, minutely warted, 8 to 11 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 133. *Chondrioderma simplex* Schroet. in Cohn Krypt. Fl. Schles., iii. pt. 1, 123 (1885); Lister in Journ.

Bot., xxxix. 85, t. 419, fig. 1*a–d*. *C. Puiggari* Speg. in Bot. Acad. Nac. Cienc. Cord., xi. 475 (1889) ?

Var. **echinulatum** Meylan in Bull. Soc. Vaud. Sc. Nat., lii. 450 (1919) (*echinus* hedgehog). Sporangia lemon- or bright yellow ; columella sometimes hemispherical, yellow.

Pl. 88.—*a*. sporangia (Scotland) ; *b*. capillitium and spores with portions of the upper sporangium-wall and of the base of the sporangium ; *c*. spore ; *d*. sporangia (Philadelphia).

The colour of the sporangia varies much in different gatherings. The type of var. *echinulatum*, on *Sphagnum* and *Polytrichum* from Le Suchet, Jura, 1400 m. alt., is of a bright yellow colour, with capillitium partly purplish, partly colourless, and with spores more strongly spinulose than in the typical form. A specimen on moss, collected on Bartlett Mountain, New Hampshire, by Prof. Thaxter (B.M. 2415) is similar except that the sporangia are of a more lemon-yellow colour, and many but not all have a well-developed yellow hemispherical hollow columella.

Hab. On moss, dead leaves or heather on moorland.—Sussex, Surrey, Norfolk, Yorks, North Wales, Aberdeenshire ; France, Germany, Moldavia, New Jersey, Pennsylvania, North Carolina, South Chili : var. *echinulatum* is recorded from the Jura Mountains and New Hampshire.

Subgenus 2.—LEANGIUM (λεῖος smooth, ἄγγος vessel). Sporangia stalked or sessile ; sporangium-wall often dehiscing in revolute lobes from the globose mass of spores, and consisting of two closely connected layers, the outer layer cartilaginous, more or less charged with included lime-granules, the inner membranous.

14. **D. Sauteri** Macbr. N. Am. Slime-Moulds, 103 (1899) (Dr. Sauter). Plasmodium opaque white. Sporangia sessile, somewhat clustered, subglobose, depressed, 0·7 to 1 mm. diam., smooth, pale pinkish- or brownish-red ; sporangium-wall of two layers, the outer cartilaginous, thin, brittle, glossy, charged with innate lime-granules, separating from the membranous inner layer. Columella hardly evident, a rugose thickening of the brownish-red base of the sporangium. Capillitium consisting of rather scanty, flaccid, sparingly branched colourless or pale violet threads, 2 to 4 μ broad, persistent at the base. Spores dark violet-brown, spinulose, 10 to 16 μ diam.—*Chondrioderma Sauteri* Rost. Mon., 181 (1875) ; Mass. Mon., 217 ; Lister Mycetozoa, 83 ; Torrend Fl. Myx., 166. *C. aculeatum* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 390.

Pl. 95.—*a*. sporangia (Portugal) ; *b*. sporangia (Salzburg, Tyrol) ; *c*. spores and capillitium, with fragments of upper sporangium-wall and columella ; *d*. spore.

This rare species appears to be nearly allied to *D. ochraceum*, from which it differs in the colour of the plasmodium, redder sporangia, colourless capillitium and larger rougher spores. The specimen in the Strasburg collection originally labelled '*Diderma deplanatum*, ex Herb. Sauter, ad muscos in montibus Salz.', is evidently Rostafinski's type of *Chondrioderma Sauteri* ; it is well described by him as ' of coffee-and-milk colour, the outer wall brittle, separating from the inner, which is membranous and colourless '. The species described by Dr. Rex as *Chondrioderma aculeatum* (B.M. slide) is similar in all respects except that the capillitium has pale

and purplish threads intermixed. A specimen in Greville's coll. in the Edinburgh Herb. marked '*Diderma* ? Appin. Carm.' is the same form and probably part of the same gathering as K. 403, named '*Diderma melaleucum* Carm.', with a descriptive note stating that it was gathered in Scotland by Captain Carmichael; it differs from the Salzburg and American gatherings in the rather darker and larger sporangia, and in the broader, almost simple threads of the more scanty capillitium.

Hab. On dead wood and moss.—Argyllshire, Tyrol, Moldavia, New York State.

15. **D. ochraceum** G. F. Hoffm. Deutsch. Fl. Crypt., t. 9, fig. 2 *b* (1795) (ὠχρός yellow earth). Plasmodium lemon-yellow. Sporangia solitary or in small clusters, sessile, hemispherical, 0·7 to 1 mm. diam., often forming curved and sometimes ring-shaped plasmodiocarps, ochraceous, rarely 'light red'; outer sporangium-wall somewhat cartilaginous, with abundant deposits of angular or round yellow lime-granules, adhering to or free from the firm membranous yellow inner wall. Columella indefinite. Capillitium consisting of abundant simple or branching purple-brown threads, often hyaline at the base. Spores purplish-grey, minutely spinulose, 9 to 11 μ.—*Reticularia ochracea* Poir. in Lam. Encycl. vi, 182 (1804). *Chondrioderma ochraceum* Schroet. in Cohn Krypt. Fl. Schles., iii. pt. 1, 124 (1885); Mass. Mon., 216; Lister Mycetozoa, 89, & in Journ. Bot., xxxix. 88, tab. 419, fig. 3*a*, and xliii. 150; Torrend Fl. Myx., 166.

Pl. 96.—*a*. sporangia (N. Wales); *b*. spores and capillitium showing attachment of threads to sporangium-wall; *c*. spore.

It appears probable that Hoffmann's type of the present species is represented by an unripe gathering marked '*Diderma ochraceum*' in Persoon's collection in the Leyden Herbarium. Fries writes that he had examined the type, but could not make out if the capillitium and columella were present or absent (Syst. Myc., iii. 111); he refers it doubtfully to *D. granulatum* (Schum.) Fr. Rostafinski gives both these names as synonyms for *Physarum conglomeratum* (Fr.) Rost., but Hoffmann's figure of the scattered sporangia, and his description of their being often traversed by the moss leaves on which they occur, are entirely characteristic of the present species. The appropriate specific name *ochraceum* appears to have been adopted independently by Schroeter for his Silesian gathering. *D. ochraceum* has repeatedly been found in company with *Lepidoderma tigrinum* (namely, in N. Wales, the Vosges Mts., Japan, and New England), a species which it resembles in capillitium and spores. Specimens of *L. tigrinum* have been found with the characteristic crystalline discs of the sporangium-wall in part replaced by angular lime-granules similar to those met with in *D. ochraceum*, and possibly we may have here varying forms of the same species. Repeated observations, however, made in a wooded ravine in North Wales, where both forms were developing daily for about a week, failed to show any connecting links; the *Lepidoderma* had always a dark orange stalk and spongy hypothallus, while the *Diderma* had, as constantly, sessile sporangia and no hypothallus; the former also matured from orange and the latter from lemon-yellow plasmodium. The two forms must be regarded at present as distinct though nearly allied species. Amongst numerous gatherings of typical *D. ochraceum* from North Wales, groups of

sporangia were found either bright or dull red-brown in colour, and with spores measuring 11 to 13 μ diam.; they differ from the type of *Chondrioderma Sauteri* Rost. only in the capillitium being purple-brown instead of colourless.

Hab. On moss and liverworts, on wet rocks.—Somerset, Northumberland, North Wales, Elginshire, and Aberdeenshire, Germany, Switzerland, Vosges Mountains, Moldavia, Japan, New England.

16. **D. Trevelyani** Fr. Syst. Myc., iii. 105 (1829) (W. C. Trevelyan (1797–1879)). Plasmodium pale yellow-brown. Sporangia scattered or clustered, globose or subellipsoid, 1 to 1·5 mm. diam., sessile or shortly stalked, rarely forming plasmodiocarps, smooth or angular, reddish or orange-brown; sporangium-wall splitting in unequal revolute petal-like lobes, white and glossy on the inner side: of three closely connected layers, the outer one cartilaginous, brown; the inner delicately membranous, giving attachment to the threads of the capillitium; the middle layer composed of coarse irregular crystals of lime. Stalk furrowed, reddish-brown, 0·1 to 0·5 mm. high, 0·1 to 0·15 mm. thick. Columella subglobose, minute, usually absent. Capillitium profuse, purple or purplish-brown, somewhat rigid, either forming a network with dark bead-like thickenings at the nodes and on the threads, or slender, branched, with few thickenings. Spores dark violet-brown, spinulose with a paler area of dehiscence, 10 to 13 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 142. *Leangium Trevelyani* Grev. Scot. Crypt. Fl., tab. 132 (1825). *Polyschismium Trevelyani* Corda Icon. Fung., v. 20 (1842). *Chondrioderma Trevelyani* Rost. Mon., 182 (1875); Mass. Mon., 202; Lister Mycetozoa, 82. *C. Oerstedtii* Rost. l.c., 184, figs. 154, 157; Mass. l.c., 203. *C. geasteroides* Phill. in Mass., l.c., 201 (1892). *Diderma geasteroides* Phill. in Grev., v. 113 (1877). *D. laciniatum* Phill., l.c. *Lepidoderma obovatum* Mass., l.c., 254 ?

Var. **nivale** Meylan in Bull. Soc. Vaud. Sc. Nat., l. 189 (1914) (*nix* snow). Sporangia rugose, orange or brown, often veined with white, bursting irregularly, usually sessile, often forming plasmodiocarps, columella convex, hemispherical or subglobose, small or large, or often wanting.

Pl. 91.—*a.* expanded sporangia (California; type of *D. geasteroides*); *b.* entire sporangia (England); *c.* capillitium and spores with fragment of sporangium-wall; *d.* spore.

The crystalline middle layer of the sporangium-wall separates this from all other species of the *Leangium* group. The type of *D. Trevelyani* described and figured under the name of *Leangium Trevelyani* Grev., is in the Edinburgh Herbarium; the sporangia were gathered by W. C. Trevelyan, who also sent a specimen to Sowerby, now in the Kew collection named *Diderma Trevelyani* (K. 1478). The specimen from Jedburgh (K. 1477), referred to by Rostafinski as *Chondrioderma Oerstedtii*, has the capillitium and the structure of the sporangium similar to Greville's type of *D. Trevelyani*; these characters are also present in the types of *D. geasteroides* Phill., and *D. laciniatum* Phill. from California. It seems probable that the type of *Lepidoderma*

obovatum Mass. is a gathering of the present species made by L. Romell at Kumla Station, Sweden, in August, 1885 (see Romell Fung. Exsic. no. 100, marked provisionally '*Didymium subcastaneum*', K. 459, B.M. 1783); Massee's description agrees with the specimen in all respects; he states that the patches of lime are *innate* in the sporangium-wall; this feature is characteristic of the genus *Diderma* rather than of *Lepidoderma*. In extensive developments of var. *nivale*, found amongst grass on the upper pastures of the Swiss Alps, most of the sporangia are of the usual character having a smooth pearly basal inner wall and showing no trace of columella, others have a small, often eccentric columella, while others again have a large subglobose columella. Associated with normal sporangia broad plasmodiocarps sometimes occur.

Hab. On dead leaves, moss, turf, &c.—Malvern, Worcestershire in April, 1914; recorded also from Leicestershire, Warwickshire, Monmouthshire, Scotland, France, Switzerland, Sweden, Germany, Colorado, California, South Chili: var. *nivale* abundant on the Swiss Alps.

17. **D. floriforme** Pers. in Roemer N. Mag. Bot., i. 89 (1794) (*flos* flower, *forma* shape). Plasmodium greyish-white. Total height 1 to 2 mm. Sporangia crowded, often forming large colonies, globose, stalked, erect, smooth, 0·8 mm. diam., varying from greyish-white to ochraceous-brown; sporangium-wall splitting into revolute petal-like lobes, pale brown on the inner side, cartilaginous, opaque, with a closely adhering membranous inner layer. Stalks cylindrical, furrowed, 0·5 to 1 mm. long, 0·15 mm. thick, ochraceous-brown, often connected below by a well-developed hypothallus. Columella clavate or hemispherical, brown, densely calcareous. Capillitium consisting of slender sparingly branching threads with scattered bead-like thickenings, thicker and anastomosing at the base, dark violet-brown. Spores red violet-brown, paler on one side, marked with scattered obtuse warts, 8 to 11 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 143. *Sphaerocarpus floriformis* Bull. Champ., 142, t. 371 (1791). *Stemonitis floriformis* Gmel. Syst. Nat., 1469 (1791). *Lycoperdon floriforme* Wither. Br. Pl. ed. 4, iv. 379 (1801). *Didymium floriforme* Schrad. Nov. Gen. Pl., 25 (1797). *Diderma spurium* Schum. Enum. Pl. Saell., ii. 197 (1803). *D. lepidotum* Fr. Syst. Myc., iii. 100 (1829). *Reticularia floriformis* Poiret in Lam. Encycl., vi. 182 (1804). *Leangium floriforme* Link in Mag. Ges. Nat. Fr. Berl., iii. 26 (1809). *L. lepidotum* Ditm. in Sturm Deutsch. Fl., Pilze, ii. 43, t. 21 (1814). *Cionium floriforme* Spreng. Syst. Orb. Veg., iv. 529 (1827). *C. lepidotum* Spreng. l.c. *Chondrioderma floriforme* Rost. Mon., 184 (1875); Mass. Mon., 198; Lister Mycetozoa, 85.

Pl. 92.—*a*. sporangia before dehiscence (England); *b*. sporangia after dehiscence; *c*. sporangia expanded and showing clavate columellae; *d*. capillitium and spores; *e*. spore.

The purplish-red spores with strong scattered warts distinguish this species from all forms of *D. radiatum*. Almost limeless developments occur with purple-brown sporangia on dark slender stalks; in other growths the

calcareous matter in both the sporangium-wall and in the stalk is partly in the form of crystalline discs.

Hab. On dead wood and twigs, not uncommon in the British Isles in autumn and winter.—Essex, Middlesex, Kent, Surrey, Hertfordshire, Bedfordshire, Norfolk, Devon, Somerset, Salop, County Dublin; widely distributed in North Temperate regions.

18. **D. radiatum** Morgan in Journ. Cinc. Soc. Nat. Hist., xvi. 151 (1894). Plasmodium white or pale yellow. Sporangia scattered or crowded, subglobose or hemispherical and depressed, flattened or umbilicate beneath, stalked or sessile, smooth or somewhat wrinkled and rimose, 0·5 to 1·2 mm. diam., pale grey, brownish or red-brown, often mottled or areolated with pale lines of dehiscence; sporangium-wall dehiscing in a stellate manner by revolute lobes, white or pale brown on the inner side; the outer layer cartilaginous, with granular deposits of lime, closely connected with the membranous inner layer. Stalk ochraceous or reddish-brown, 0·2 to 0·6 mm. high, usually short and stout, enclosing white lime deposits. Columella hemispherical or subglobose, white or cream-coloured, densely calcareous. Capillitium abundant, dark violet-brown, radiating from the columella in somewhat rigid threads, sparingly branched except at the colourless extremities, rarely pale, slender and flexuose. Spores dark violet-brown, closely and minutely spinulose, 9 to 12 μ diam. —Macbr. N. Am. Slime-Moulds, ed. 2, 141. *Lycoperdon radiatum* L. Sp. Pl., ed. 2, 1654 (1763). *Didymium stellare* Schrad. Nov. Pl. Gen., 21, t. v. figs. 3, 4 (1797). *D. Geaster* Link in Mag. Ges. Nat. Fr. Berl., vii. 42 (1815). *D. complanatum* Fuckel Symb. Myc., 341 (1869). *Diderma stellare* Pers. Syn. Fung., 164 (1801); Fries Syst. Myc., iii. 98 (1829). *Leangium stellare* Link l.c., iii. 26 (1809). *Cionium stellare* Spreng. Syst. Orb. Veg., iv. 529 (1827). *Chondrioderma radiatum* Rost. Mon., 182 (1875); Mass. Mon., 200; Lister Mycetozoa, 83.

Var. **umbilicatum** Meyl. in Ann. Cons. Bot. Genève (1913), 312 (having a navel-like hollow). Sporangia pearl-white or drab, dehiscing irregularly.—*Diderma umbilicatum* Pers. l.c., 165; Fr. l.c., 99. *D. crassipes* Schum. Enum. Pl. Saell., ii. 196 (1803). *D. Carmichaelianum* Berk. & Sm. Engl. Fl., v. pt. ii. 311 (1836). *D. concinnum* Berk. & Curt. in Grev., ii. 52 (1873), see Journ. Bot., xxxv. 212. *Reticularia umbilicata* Poiret in Lam. Encycl., 183 (1804). *Cionium umbilicatum* Spreng. Syst. Veg., iv. 529 (1827). *Chondrioderma Carmichaelianum* Cooke Myx. Brit., 42 (1877); Mass. Mon., 202, in part.

Var. **rubrum** Rönn in Schr. Naturwiss. Ver. Schl.-Holst., xv. 59 (1911) (red). Plasmodium coral red; sporangia greyish-pink, dehiscing in petal-like lobes; lime in stalk and columella pink.

Pl. 93.—*a*, sporangia of var. *umbilicatum* (Devon); *b*, sporangia dehiscing irregularly and showing the hemispherical columella; *c*, capillitium and spores with fragment of the sporangium-wall; *d*, spore.

Pl. 94.—*a*, sporangia of typical form with walls dehiscing in lobes (Northumberland); *b*, capillitium and spores.

This variable species presents two well-marked forms. One, represented by the type of *Lycoperdon radiatum* in the Linnean Herbarium, London, has brown often mottled sporangia whose walls dehisce in a stellate manner (fig. 94*a*). The second, var. *umbilicatum*, has pale grey or drab sporangia that dehisce irregularly (fig. 93*a*); this is the commonest form in the British Isles, and was described by Persoon as a distinct species, *D. umbilicatum*, but gatherings of intermediate character frequently occur. Sometimes the lime is only partially present, forming a white cap to a dark sporangium, or the sporangia may be entirely brown with little or no lime in the wall. Very closely allied to var. *umbilicatum* is *D. montanum*, q.v. The plasmodium is usually pale yellow or almost white, but the var. *rubrum*, found by Dr. H. Rönn in the neighbourhood of Kiel, has coral-red plasmodium. The specimen in Berkeley's herbarium named *Diderma Carmichaelianum*, K. 354, is a sessile form of var. *umbilicatum*; no note as to locality is given; it agrees perfectly, however, with Berkeley's description of *D. Carmichaelianum*, and is probably his type from Appin, N.B. Rostafinski has marked the label '*Chondrioderma radiatum*'.

The type of *Chondrioderma Stahlii* Rost. from near Strasburg does not appear in the quoted collections. It is described as follows:—Sporangia globose, brownish, glossy; sporangium-wall with scanty deposits of lime-granules, dehiscing irregularly; columella none, stalk brown, shining; the capillitium consisting of dull violet, simple or branching threads 1·2 to 2·3 μ diam.; the spores pale violet, faintly warted, 9·2 μ diam. Possibly this may be a form of *D. radiatum*, the columella of which is sometimes inconspicuous.

Hab. On dead leaves and twigs: the typical form widely distributed in Europe and the United States, rare in Britain: var. *umbilicatum* not uncommon in Great Britain in autumn and winter; widely distributed in Europe; recorded also from N. India, New South Wales, Japan, and from many of the United States: var. *rubrum* N. Germany.

19. **D. roanense** Macbr. N. Am. Slime-Moulds, 104 (1899) (Roan Mountain, Tennessee). Plasmodium ? Sporangia scattered, stalked, hemispherical, depressed or discoidal, 0·8 to 1·2 mm. diam., mottled red-brown, or dark umber, with paler lines of dehiscence; sporangium-wall dehiscing irregularly or in a somewhat stellate manner, consisting of two layers, the outer cartilaginous, brown on the outer white on the inner side, more or less adhering to the membranous inner layer. Stalk rather slender, black, furrowed, 0·1 to 0·7 mm. high. Columella flat, discoidal, ochraceous-brown. Capillitium consisting of slender simple or branched colourless threads. Spores purplish-brown, spinulose, 10 to 14 μ diam.—*Chondrioderma roanense* Rex in Proc. Ac. Nat. Sci. Phil. 1893, 368.

Pl. 94.—*c*. sporangia (Tennessee); *d*. capillitium and spores with fragment of sporangium-wall.

Allied to *D. radiatum*, from which it is distinguished by the discoid shape of the sporangia and the black stalks. Intermediate forms apparently connecting the two species have been gathered by Dr. Sturgis and Prof. Bethel in Colorado.

Hab. On dead wood.—Maine, New Hampshire, Tennessee, Colorado.

20. **D. asteroides** Lister Mycetozoa, ed. 2, 113 (1911) (ἀστήρ star). Plasmodium cream-yellow to bright orange. Sporangia

scattered or crowded, hemispherical or somewhat conical, 0·6 to 0·8 mm. high, sessile, seldom either shortly stalked or forming plasmodiocarps, purplish-brown, bright chocolate- or pinkish-brown, often mottled with darker spots or marked with numerous darker lines radiating from near the apex to the base of the sporangium; sporangium-wall dehiscing in a stellate manner into from eight to twenty reflexed lobes, snow-white on the inner side, the outer layer brown, cartilaginous, with abundant deposits of lime on the inner side, usually connected with the membranous inner layer. Stalk stout, white, filled with lime-granules, 0·2 mm. high, often arising from a white hypothallus. Columella hemispherical, or subglobose and depressed, white or cream-coloured. Capillitium of slender simple or anastomosing colourless or purplish threads. Spores purple-brown, minutely warted, 9 to 12 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 143. *Chondrioderma asteroides* Lister in Journ. Bot., xl. 209, tab. 438, fig. 1 *a-c* (1902); Torrend Fl. Myx., 166.

Pl. 97.—*a*. sporangia (La Mortola, Italy); *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

A constant form, closely allied to *D. radiatum* differing in the dark, sessile, and usually rather conical sporangia. In Sept. 1912 it appeared in great profusion on deep beds of holly leaves near Cawdor, N.B. Gatherings made by Dr. Sturgis on Cheyenne Mt., Colorado, differ from the type only in the more globose less conical shape of the sporangia. M. Meylan describes a form from the Jura Mountains in which the sporangium-wall is yellow on the inner side, and which he names var. *luteum* (Bull. Soc. Vaud. Sc. Nat., liii. 454 (1921)).

Hab. On dead bark, leaves and pine-needles.—Somerset, Surrey, Norfolk, Salop, Scotland, Germany, Switzerland, Italy, Portugal, Moldavia, Colorado, California, and Oregon.

21. **D. antarctica** Sturgis in Mycologia, viii. 37 (1916). Plasmodium ? Sporangia crowded, sessile, subglobose or angled by mutual pressure, smooth, dark reddish-brown, mottled, 0·7 to 1 mm. diam.; sporangium-wall brittle, cartilaginous, cream-coloured on the inner side, the two layers closely adhering and enclosing deposits of white lime-granules. Columella hemispherical, cream-coloured, rugged, with rounded and spike-like processes. Capillitium consisting of rigid stout and slender, branching and anastomosing pale and dark purplish threads, with irregular wide membranous expansions. Spores dark purplish-brown, with a paler band of dehiscence, closely spinulose, often marked with dark ridges, 11 to 12 μ diam.—*Licea antarctica* Speg. in Bot. Acad. Nac. Cienc. Cord., xi. 56 (1887).

Pl. 209.—*a*. group of sporangia, three of which are broken and show the rugged columella; *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

This rare species bears some resemblance to *D. asteroides*, but the sporangia are more crowded, and the capillitium is more rigid; the presence of large irregular membranous expansions suggests a somewhat abnormal develop-

ment. It has been found twice on dead leaves and twigs of *Notofagus antarctica* near Puntas Arenas, South Chili, in 1887 by Dr. Spegazzini, and in 1906 by Prof. Thaxter.

Hab. On dead leaves and twigs.—South Chili.

22. **D. rugosum** Macbr. N. Am. Slime-Moulds, 105 (1899) (wrinkled). Plasmodium grey. Total height 0·7 to 1 mm. Sporangia scattered, stalked, rarely sessile, subglobose or hemispherical, 0·5 to 0·6 mm. diam., greyish-white, brown at the base, reticulated with wrinkles which divide the wall into 25 to 30 irregularly polyhedral portions ; sporangium-wall single, papyraceous, with scanty deposits of lime in minute granules. Stalk subulate, 0·2 to 0·6 mm. high, furrowed, black. Columella clavate, about half the height of the sporangium, rugose, chalky or yellowish-white. Capillitium consisting of slender colourless or purplish threads, anastomosing and branching towards the tips. Spores violet- or purplish-brown, minutely warted, 8 to 14 μ diam.—*Chondrioderma rugosum* Rex in Proc. Acad. Nat. Sci. Phil. 1893, 369 ; Lister Mycetozoa, 84 ; Petch in Ann. Perad., iv. 345.

Pl. 86.—*a.* sporangia (N. Carolina) ; *b.* capillitium and spores with fragment of sporangium-wall ; *c.* spore.

This species is distinguished by the wrinkled sporangia, the black stalks, and the clavate white columellae. Dr. M. Brandza has found a sessile form in some abundance on mossy beech trunks in sub-alpine woods in Moldavia ; the clavate columellae are often irregular in shape and may give off spike-like branches ; the spores are purplish-brown, 10 to 12 μ diam.

Hab. On dead wood and moss, or on the bark of living trees.—Moldavia, Ceylon, Japan, West Indies, North Carolina, Florida, and Iowa.

23. **D. lucidum** Berk. & Br. in Ann. Mag. Nat. Hist., ser. 3, vii. 380, t. xv, a, fig. 9 (1861) (shining). Plasmodium orange-yellow. Sporangia scattered, subglobose, flattened beneath, 0·8 mm. diam., usually stalked, orange or vermilion, glossy, dehiscing irregularly or by four or five lobes that become pale at the margins ; outer layer of sporangium-wall translucent orange-yellow, with scanty deposits of lime on the inner side, closely connected with the yellow inner layer. Stalk slender, subulate, brownish-black, 0·2 to 0·5 mm. high. Columella obconic or subglobose, often shortly stalked, rugose, white or cream-coloured, filled with lime-granules. Capillitium forming a scanty and irregular network of stout purple-brown threads, often expanded at the axils. Spores purplish-grey, closely spinulose, 13 to 15 μ diam.—*Chondrioderma lucidum* Cooke Myx. Brit., 42 (1877) ; Mass. Mon., 204 ; Lister Mycetozoa, 86, and in Journ. Bot., xxxix. 87. *C. Carmichaelianum* Mass. Mon., 202 (1892), in part.

Pl. 98.—*a.* sporangia ; *b.* sporangium broken and showing the columella ; *c.* capillitium and spores with fragment of sporangium-wall ; *d.* spore (North Wales).

Berkeley gives two localities for this species, Trefriw in Carnarvonshire, and Cumberland. Examples of the former gathering are in the British

Museum (B.M. 25) under the name *Diderma lucidum*, and in Berkeley's collection at Kew, marked by him '*Diderma Carmichaelianum*, ex Herb. Broome' (K. 353). The Cumberland gathering is not represented in the quoted collections. Since the first gathering in 1860, *D. lucidum* has been found in two other stations in North Wales, once near Dolgelly, and frequently in a ravine near Llanymawddwy, where it has appeared in some abundance for several years in succession on moss on wet rocks.

A remarkable specimen, nearly allied to *D. lucidum*, has been gathered by Mr. Petch on bark, at Telawakelee, Ceylon, in August, 1905 (see Petch in Ann. Perad., iv. 346). It consists of about ten clustered and almost sessile sporangia, 0·6 mm. diam.; when first found they were bright yellow, but on exposure to sunlight they faded to pale yellowish-buff; their surface is smooth, but pitted with thirty to fifty shallow pits or depressions; the sporangium-wall is cartilaginous and contains abundant deposits of yellow lime-granules between the outer and inner layers; beneath each of the above-mentioned pits the wall is produced on the inner side into a stout, pale yellow process filled with lime-granules; some of these processes are short, others are long and spike-like and either end freely in the cavity of the sporangium or are connected with the columella; the latter is large, pale yellow, globular or clavate, and rough with spike-like processes containing lime-granules; a very short black stalk is present in one sporangium; the capillitium is a scanty network of rather stout purple-brown threads; the spores are purplish-grey, spinulose, and measure 14 to 16 μ diam. It is probable that the spike-like processes of the columella and inner sporangium-wall are due to abnormal development; irregular growths of *D. lucidum* occasionally show similar though much shorter ingrowths from the sporangium-wall associated with a columella having a lobed and rough surface. Until further gatherings have been obtained confirming the distinctive characters of the Ceylon specimen, it may be placed provisionally with *D. lucidum*.

Hab. On moss on wet rocks.—Trefriw and Llanymawddwy, North Wales.

Genus 12.—**PHYSARINA** von Höhnel in Sitzungsb. k. Akad. Wiss. Wien, Math.-nat. Kl., I. cxviii. 431 (1909). (*Physarum.*) Sporangia stalked, rough with numerous cylindrical blunt spine-like processes projecting from the surface of the sporangium-wall. Capillitium threads without lime-knots.

Closely allied to *Diderma*, from which it differs in the structure of the sporangium-wall.

1. **P. echinocephala** von Höhnel l.c., 432, fig. 33 (ἐχῖνος hedgehog, κεφαλή head). Plasmodium ? Sporangia gregarious, stalked, subglobose, 0·4 to 0·5 mm. diam., pale pink or flesh-coloured; sporangium-wall of two layers, the outer layer somewhat cartilaginous, enclosing lime-granules and produced into numerous (60 to 100) blunt-ended cylindrical processes, 25 to 40 μ wide, and 80 μ long, filled with lime-granules; the inner layer smooth, membranous, more or less adhering to the outer. Stalk stout, conical, furrowed, flesh-coloured or nearly white, 0·1 to 0·4 mm. high, filled with lime-granules, continued above into a pale subglobose or hemispherical columella. Capillitium-threads violet-brown,

paler and branching at the extremities. Spores nearly smooth, brownish-violet, 7 to 9 μ diam.

Pl. 198.—*a*. sporangia ; *b*. capillitium and spores with a fragment of sporangium-wall showing one of the spine-like prominences ; *c*. spore (Java).

This remarkable species has been recorded only from Java, where it was gathered by both Prof. R. Ernst and Prof. F. v. Höhnel. The latter describes the colour of the sporangia as blackish chocolate-brown, but the sporangia received from him, and those of Prof. Ernst's gathering in the Zürich Herbarium, are pale flesh-coloured.

Hab. On dead leaves.—Java.

Genus 13.—**DIACHEA** Fries Syst. Orb. Veg., i. 143 (1825) (διαχέω to fall to pieces). Sporangium-wall hyaline, iridescent, without deposits of lime. Walls of stalk and columella membranous, charged with lime in the form of granules or crystalline nodules, sometimes without lime. Capillitium a profuse network of purplish threads, without lime-knots.

This genus forms a connecting link between the *Calcarineae* and the *Stemonitaceae*. The limeless forms closely resemble some species of *Lamproderma*, but are distinguished by having the walls of the columella and stalk membranous. (Syn. *Diachaea* Cooke Brit. Fungi, 395 (1871) ; Lister Mycetozoa, 90 (1894).)

KEY TO THE SPECIES OF *DIACHEA*.

A. Sporangia globose :—

A. Lime in stalk white, sometimes absent.

Spores spinulose or with dark raised bands and tubercles. 2. *D. bulbillosa*

Sporangia usually sessile, spores minutely warted. 3. *D. radiata*

Spores delicately reticulated. 4. *D. subsessilis*

B. Lime in stalk orange. 5. *D. Thomasii*

C. Sporangia on stout black or brown stalks, lime absent. 6. *D. cerifera*

B. Sporangia cylindrical (globose in *D. leucopoda* var. *globosa*).

Spores nearly smooth ; lime in stalk white. 1. *D. leucopoda*

Spores delicately reticulated ; lime absent. 7. *D. cylindrica*

Spores warted ; lime absent. 8. *D. caespitosa*

1. **D. leucopoda** Rost. Mon., 190, fig. 178 (1875) (λευκός white, ποῦς foot). Plasmodium opaque white. Sporangia gregarious, cylindrical, obtuse, stalked, 0·7 mm. high by 0·25 mm. broad, iridescent purple ; sporangium-wall membranous, hyaline. Stalk white or pale reddish-brown, stout, brittle,

furrowed, one-third or one-half the height of the sporangium, broad at the base, rising from a well-developed hypothallus, densely charged with lime in the form of round granules or crystalline nodules. Columella cylindrical or narrowed upwards, reaching half-way or nearly to the apex of the sporangium, white, densely charged with lime in the form of granules, sometimes in the form of crystalline nodules. Capillitium consisting of profusely branched and anastomosing threads connecting the columella with the sporangium-wall, dark violet-brown, colourless at the extremities. Spores dull violet, minutely spinulose, 7 to 9 μ diam.—Mass. Mon., 259; Macbr. N. Am. Slime-Moulds, ed. 2, 186. *Trichia leucopodia* Bull. Champ., 121, t. 502, fig. 2 (1791). *Stemonitis elegans* Trentep. in Roth Catal. Bot., i. 220 (1797). *S. leucostyla* Pers. Syn. Fung., 186 (1801). *S. leucopodia* DC. Fl. Fr., ii. 257 (1805). *Diachea elegans* Fr. Syst. Orb. Veg., i. 143 (1825); Lister Mycetozoa, 91. *D. confusa* Mass. Mon., 259 (1892).

Var. **globosa** Lister Mycetozoa, ed. 2, 118 (1911). Sporangia globose.

Pl. 99.—*a*. sporangia (England); *b*. capillitium and spores; *c*. spore.

This abundant and widely distributed species often forms large plasmodia which produce many hundred sporangia. *D. confusa* Mass. from Jamaica is typical *D. leucopoda*, except that the lime in the stalk and columella is in the form of crystalline nodules instead of lime-granules, but this modification is not unfrequent in otherwise normal growths of *D. leucopoda*. An interesting variety of forms appears in a large colony found by Mr. H. J. Howard in a wood near Norwich, July 1916. All stages occur between typical cylindrical sporangia on white stalks and sessile globose limeless sporangia or even short plasmodiocarps; the columellae are either in the form of cylindrical tubes, with or without lime, or are represented by a chain of flattened empty vesicles.

Hab. On dead leaves and sticks; frequent in the British Isles in summer and autumn, and widely distributed in both temperate and tropical regions: var. *globosa* recorded from Norfolk, Switzerland, Java, Japan, New Hampshire, and Chili.

2. **D. bulbillosa** Lister in litt., ex Penzig Myx. Buit., 47 (1898) (with a small bulb). Plasmodium white. Sporangia gregarious, globose, stalked, 0·3 to 0·45 mm. diam., shining iridescent blue or purple; sporangium-wall membranous, colourless. Stalk conical, 0·3 to 0·5 mm. high, expanded at the base, either white throughout and filled with lime-granules, or brown and more slender above, and containing lime in the form of crystalline nodules. Columella clavate, white or brown, containing lime in the form of minute granules or in nodules, or entirely without lime. Capillitium a rather lax network of purple-brown threads, spreading from the columella to the sporangium-wall. Spores violet-grey, marked with scattered warts (from six to eight in a row across the hemisphere), 7 to 11 μ diam.—Lister in Journ. Bot., xxxvi. 165,

tab. 386, fig. 10 (1898); Petch in Ann. Perad., iv. 315, 347. *Didymium bulbillosum* Berk. & Br. in Journ. Linn. Soc., xiv. 84 (1873). *Diachaea splendens* Racib. in Hedw., xxxvii. 54 (1898). *Diachaeella bulbillosa* v. Höhnel in Sitzungsber. k. Akad. Wiss. Wien, Math.-nat. Kl., I. cxviii. 437, fig. 34 (1909).

Var. **splendens** G. Lister (shining). Spores marked with scattered tubercles, more or less connected by low ridges to form an imperfect reticulation.—*Diachaea splendens* Peck in Rep. N. York Mus. Nat. Hist., xxx. 50 (1878): Lister Mycetozoa, ed. 2, 120: Macbr. N. Am. Slime-Moulds, ed. 2, 187.

Pl. 99.—*d.* sporangia of var. *splendens*; *e, f.* capillitium and spores of same; *g, h.* spores of typical form.

This species is closely allied to the globose form of *D. leucopoda*, but differs in having the spores marked with strong scattered warts or ridges. Since the first gathering was made by Thwaites in Ceylon, in 1867, *D. bulbillosa* has again been found abundantly in that island by Mr. Petch, on dead leaves, and Prof. Penzig records it as being a common species in Java. It has been made the type of a new genus, *Diachaeella*, by Prof. v. Höhnel on account of the nodular character of the lime in the stalk and columella, but this feature is by no means constant, and may occur also in *D. leucopoda* and *D. subsessilis*. Gatherings from Ithaca, New York, made by W. C. Muenschen (B.M. 3911) show, in a single sporangium, a great variety of spore markings—fine and coarse warting, the warts evenly distributed or grouped in clusters, or united to form ridges—thus completely uniting the characters of *D. bulbillosa* and *D. splendens* Peck, and proving that the latter is merely a variety with rougher spores.

Hab. On dead leaves and sticks.—India, Ceylon, Java, United States.

3. **D. radiata** G. Lister and Petch in Journ. Bot., liv. 130, tab. 541, figs. 2, 2*a–d* (1916) (spreading in rays). Plasmodium orange-yellow. Sporangia loosely clustered or crowded in large colonies, hemispherical or globose, 0·4 to 0·5 mm. diam., sessile, rarely stalked, iridescent grey or bronze, seated on a white hypothallus; sporangium-wall membranous, colourless. Stalks, when present, short, stout, furrowed, charged with white lime-granules. Columella white, convex, conical or shortly cylindrical. Capillitium a network of slender purple-brown threads radiating from the columella. Spores pale violet-grey, spinulose or warted, 8 to 11 μ.

Pl. 211.—*a.* group of sporangia seated on a rugose hypothallus; *b.* capillitium and columella; *c.* capillitium and spores; *d.* spore.

Numerous large colonies of this species were seen by C. O. Farquharson in South Nigeria; he described the orange plasmodium emerging from the soil (where it had been feeding probably on decaying bean-stalks, dug in for green manure) and forming circular patches of slender veins, 'radiating in a somewhat dendritic manner and covering an area of from three to five inches across'. The radiating growth is often preserved in the lines of hypothallus. In a large gathering from Ceylon the columella is often almost or quite free from calcareous deposits, and consists of a slender colourless or pale yellow membranous tube. From *D. leucopoda* var. *globosa* the present species is distinguished by the colour of the plasmodium and the crowded, usually sessile sporangia.

Hab. On dead leaves and sticks.—Ceylon and South Nigeria.

4. **D. subsessilis** Peck in Rep. N. York Mus. Nat. Hist., xxxi. 41 (1879) (almost sessile). Plasmodium yellow. Sporangia gregarious, globose, 0·5 mm. diam., stalked, rarely sessile and forming short plasmodiocarps, shining iridescent-purple or bronze ; sporangium-wall membranous, colourless. Stalk stout, conical, white and filled either with lime-granules or crystalline nodules of lime, or dark brown and without lime, 0·2 to 0·5 mm. high. Columella conical, white, yellowish or brown, rarely none. Capillitium radiating from the columella and consisting of branched and anastomosing purple-brown threads, usually stouter and paler below, slender and colourless at the tips. Spore-walls purplish-grey, with yellow contents when freshly formed giving a purplish-green effect, reticulated with rows of minute close-set warts, forming a net with about six meshes across the hemisphere, 7 to 10 μ.—Mass. Mon., 262 ; Rex in Proc. Acad. Nat. Sci. Phil. 1893, 368 ; Burrell in Trans. Norf. Nat. Soc., vi. 449, plate ; Petch in Ann. R. Bot. Gard. Perad., iv. 347. Macbr. N. Am. Slime-Moulds, ed. 2, 187. *D. fulgens* Fr. ex Weinm. Hymeno-Gastero-myc., 611 (1836) ? *Lamproderma Fuckelianum* Rost. Mon., 208, t. xiii, fig. 6 (1875) ?

Pl. 100.—*a*. sporangia with white stalks (Bedfordshire) ; *b*. sporangia with short black stalks, and sessile sporangia ; *c*. capillitium and spores ; *d*. spore.

Sporangia with limeless stalks, dark from enclosed refuse matter, are often found associated with others having white stalks containing lime-granules only. When the limeless form occurs alone it resembles a *Lamproderma* externally, but is distinguished by the membranous stalk and columella. Through the courtesy of Dr. Čelakovsky we have seen a glycerine preparation of *Lamproderma Fuckelianum* Rost. var. *cracowense* Racib. ; it is a form of the present species without lime in the pale membranous columella and short stalk ; the spores are purplish-grey, empty of protoplasmic contents, and are closely reticulated with delicate raised lines. The type of *L. Fuckelianum* Rost. is not represented in the quoted collections, but Rostafinski's illustration exactly represents the black-stalked limeless form of *D. subsessilis* ; in the absence of the type of *L. Fuckelianum*, however, it would seem better to retain Peck's specific name although it is of later date.

Hab. On dead leaves and sticks.—Bedfordshire, Worcestershire, Salop, Norfolk, Isle of Wight, Pitlochrie, N.B., France, North Germany, Switzerland, Ceylon, Java, West Indies, Connecticut to Colorado.

5. **D. cerifera** G. Lister in Journ. Bot., li. 3, tab. 525 (1913). (*cera* wax, *fero* I bear.) Plasmodium white. Sporangia scattered or in small clusters, stalked, subglobose or ovoid, 0·7 to 1·2 mm. diam., shining iridescent brownish-purple ; sporangium-wall membranous, hyaline, or yellowish and persistent towards the base. Stalk brownish-black, yellowish-brown or white, 0·2 to 0·6 mm. high, 0·15 to 0·5 mm. thick ; when black it may have a thick yellow waxy collar at the apex on which the sporangium rests. Columella none, or represented by the flattened convex summit of the stalk. Capillitium consisting

of rigid, dark purplish threads, pale at the extremities, branched and anastomosing. Spores purplish-grey, pale or dark, closely spinulose, 10 to 18 μ diam.

Pl. 212.—*a*. Two broken sporangia with a waxy collar encircling the summit of the stalk; in one sporangium a brush of capillitium remains, in the other fragments of the sporangium-wall persist round the mass of capillitium and spores (Japan); *b*. sporangium without a collar (Somerset); *c*. nearly sessile sporangium, broken and showing discoid columella (Norway); *d*. capillitium and spores; *e*. two spores with either close or scattered warts or spinules.

The first specimen of this species was found by Prof. Blytt near Christiania in 1891, and is described in Mycetozoa, ed. 2, 165, under *Lamproderma columbinum* var. *sessile*. Six other specimens, received since, show the affinities to be more with *Diachea* than *Lamproderma*. Two were found on different occasions in Japan by Mr. K. Minakata, two in the Jura Mountains by M. Meylan, the fifth Mr. N. G. Hadden watched developing from plasmodium near Porlock, Somerset; Dr. Brandza finds it also in Moldavia. It differs from all other species of *Diachea* in the stalks, which are translucent yellowish-brown with transmitted light, and exude a yellow wax-like substance when crushed. The Japanese sporangia alone are provided with a yellow collar of wax, which stains crimson with alkannin.

Hab. On moss and hepatics on dead wood or earth.—Somerset, Norway, Switzerland, Moldavia, Japan.

6. **D. Thomasii** Rex in Proc. Acad. Nat. Sci. Phil. 1892, 329 (Mr. Lancaster Thomas). Plasmodium rich yellow. Sporangia globose, shortly stalked or sessile, scattered or crowded, forming large colonies, seated on a common orange hypothallus, 0·6 to 0·7 mm. diam., iridescent copper-coloured or violet-blue; sporangium-wall membranous, hyaline. Stalk short, stout, rich orange, densely charged with orange lime-granules, continued above into the conical or shortly cylindrical columella. Capillitium radiating from all parts of the columella, composed of rather rigid violet-brown threads, branching and anastomosing, tapering to the hyaline extremities. Spores grey with yellow contents resulting in an olive-coloured effect, marked with small scattered warts, and four to eight little dark patches which a high magnifying power resolves into a compact cluster of minute warts, 9 to 11 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 188.

Pl. 101.—*a*. sporangia; *b*. capillitium and spores; *c*. spore (N. Carolina).

This handsome species appears to have been found in two localities only, near Cranberry, North Carolina, in 1891, and again in 1894 by Mr. Lancaster Thomas, and at Burbank, Tennessee, in 1897 by Prof. Thaxter.

Hab. On dead bark and moss.—Cranberry, North Carolina, and Tennessee.

7. **D. cylindrica** Bilgram in Proc. Acad. Nat. Sci. Phil. 1905, 524. Plasmodium? Sporangia clustered in small groups, cylindrical, sessile, 1 to 1·7 mm. high, 0·5 to 0·65 mm. thick, shining iridescent-bronze or steel-grey; sporangium-wall membranous, colourless, at length breaking away in large flakes. Columella without lime, pale brown, membranous, slender, extending nearly to the apex of the sporangium,

tubular, or discontinuous and breaking up into irregular branching strands. Capillitium consisting of branched and anastomosing purplish-brown threads, spreading from all parts of the columella, slender and colourless at the tips. Spores pale purplish-grey, 11 to 12 μ diam., reticulated as in *D. subsessilis* with rows of minute spines.—Sturgis in Mycologia, ix. 327. *Comatricha cylindrica* Macbr. N. Am. Slime-Moulds, ed. 2, 173 (1922).

Pl. 103.—*a*. sporangia (Philadelphia); *b*. sporangium after dispersion of spores; *c*. capillitium and spores; *d*, *e*. spores.

This species was first gathered by Dr. Rackstraw, in Fairmount Park, Philadelphia; several years later it was found again at a spot about nine miles distant, by Mr. Hugo Bilgram; it has also been gathered in New Hampshire by Prof. Thaxter. It closely resembles *D. caespitosa*, from which it differs in having reticulated spores.

Hab. On dead leaves and twigs.—Philadelphia and New Hampshire.

8. **D. caespitosa** Lister in Journ. Bot., xlv. 186 (1907) (clustered). Plasmodium ? Sporangia in clusters of six to thirty, cylindrical or clavate-cylindrical, sessile or shortly stalked, 0·7 to 1·5 mm. high, 0·5 mm. thick, iridescent blue or bronze; sporangium-wall membranous, colourless, soon breaking away above, more persistent below. Stalk slender, dark brown, 0·1 mm. high, not enclosing lime-granules, arising from a yellowish membranous hypothallus. Columella without lime, a slender, membranous wrinkled tube, brown below, yellowish above, reaching nearly to the apex of the sporangium. Capillitium a network of purple-brown threads spreading from all parts of the columella. Spores with pale purplish-grey walls enclosing yellow or colourless contents, marked with small scattered warts, and several clusters of rather stronger warts, 9 to 11 μ.—*Comatricha caespitosa* Sturgis in Bot. Gaz., xviii. 186, t. xx, figs. 1 to 4 (1893); Macbr. N. Am. Slime-Moulds, ed. 2, 173. *Diachaea Thomasii* Rex, var. ? Lister Mycetozoa, 92 (1894).

Fig. 103.—*f*. sporangia; *g*. sporangium after dispersion of spores; *h*. capillitium and spores; *i*, *j*. spores (Woods Holl, Mass.).

This species was placed originally by Dr. Sturgis in the genus *Comatricha*; he now agrees that its affinities are with *Diachea* on account of the membranous although limeless character of the stalk and columella. It is closely allied to *D. cylindrica*, differing chiefly in the markings on the spores.

Hab. On moss and lichen: recorded from the States of Maine, Massachusetts and North Carolina.

Family II.—Didymiaceae.

Deposits of lime in the form of crystals or crystalline discs distributed over the sporangium-wall; capillitium without lime-knots (except in *Didymium anomalum*); sporangia simple, except in *Mucilago* when they are combined into an aethalium.

KEY TO THE GENERA OF *DIDYMIACEAE*.

Lime-crystals stellate ; sporangia single. (14) DIDYMIUM.

Fig. 22.—*Didymium squamulosum* Fr.

a. Two sporangia, one entire, the other showing columella and capillitium. Magnified 12 times.

b. Capillitium and fragment of sporangium-wall, with crystals of calcium carbonate and two spores. Magnified 200 times.

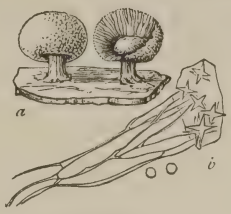


Fig. 22.

Lime-crystals stellate, heaped together, at first concealing the confluent sporangia. (15) MUCILAGO.

Fig. 23.—*Mucilago spongiosa* Morg.

a. Aethalium. Natural size.

b. Capillitium and fragment of sporangium-wall, with crystals of calcium carbonate and two spores. Magnified 200 times.



Fig. 23.

Lime-crystals more or less lenticular and scale-like, thickly scattered over the sporangium-wall. (16) LEPIDODERMA.

Fig. 24.—*Lepidoderma tigrinum* Rost.

a. Sporangium. Magnified 6 times.

b. Capillitium and spores. Magnified 140 times.



Fig. 24.

Crystals few, minute, flat, sometimes wanting. (17) LEPTODERMA.

Fig. 25.—*Leptoderma iridescens* G. Lister.

a. Group of sporangia. Magnified 10 times.

b. Sporangium after dispersion of spores. Magnified 15 times.

c. Capillitium and piece of sporangium-wall with crystals. Magnified 140 times.



Fig. 25.

Genus 14.—**DIDYMIUM** Schrader Nov. Gen. Plant., 20 (1797) (δίδυμος double). Sporangia stalked, sessile, or forming plasmodiocarps; sporangium-wall membranous or cartilaginous, with superficial crystals of lime either scattered over the surface or combined into a separable crust. Capillitium of branching threads, which are often thickened at intervals with dark calyciform nodes, in normal developments without lime-knots: in *D. anomalum* consisting of simple tubes containing lime-crystals.

The subgenus *Lepidodermopsis* forms a connecting link between the true *Didymia* and the genus *Lepidoderma*, having the superficial stellate crystals of the former, and the cartilaginous sporangium-wall of the latter.

KEY TO THE SPECIES OF *DIDYMIUM*.

Subgenus 1.—Eudidymium. Sporangium-wall membranous.

A. Crystals closely combined to form a thin eggshell-like crust:—

Sporangia sessile, pulvinate; capillitium threads scanty, broad at the base, or profuse and slender throughout; spores nearly smooth. 1. *D. difforme*

Sporangia sessile, pulvinate; capillitium a network of stout purple threads; spores rough with close-set warts and ridges. 2. *D. quitense*

Sporangia pulvinate or branching plasmodiocarps; spores rough with short spines. 3. *D. trachysporum*

Sporangia sessile, flat or convex; capillitium dark, profuse, slender at the points of attachment. 4. *D. dubium*

Sporangia turbinate, shortly stalked or sessile; capillitium rigid, usually colourless. 5. *D. vaccinum*

B. Crystals scattered or loosely combined into a crust:—

A. Plasmodiocarps; capillitium associated with large olive-coloured vesicles. 6. *D. complanatum*

B. Sporangia stalked, sessile or forming plasmodiocarps; capillitium without vesicles; spores more or less spinulose:—

a. Sporangia disc-shaped, with dark stalks. 7. *D. Clavus*

b. Sporangia subglobose or effused—

Stalk and columella dark brown; stalk opaque and granular. 8. *D. melanospermum*

Stalk olive-brown or orange, translucent, not granular. 9. *D. nigripes*

Stalk and columella white or yellowish ; crystals on sporangium-wall scattered or forming a wrinkled crust ; sporangia often forming plasmodiocarps, dehiscing irregularly. 10. *D. squamulosum*

Plasmodiocarps effused ; capillitium of simple tubes containing lime-crystals. 11. *D. anomalum*

Sporangia forming slender plasmodiocarps with scanty lime deposits, dehiscing in a circumcissile manner ; columella none. 12. *D. anellus*

Sporangia forming large pulvinate plasmodiocarps, 1 to 20 mm. long, dehiscing irregularly ; columella none ; capillitium forming an abundant elastic network. 13. *D. Wilczekii*

Stalk short, membranous, pale buff ; crystals on sporangium-wall forming a smooth, thick, deciduous envelope. 14. *D. crustaceum*

Sporangia usually forming plasmodiocarps, with orange-spotted walls and orange columellae. 16. *D. fulvum*

c. Sporangia with orange stalks ; sporangium-wall hyaline ; spores dark brown, closely reticulated. 15. *D. intermedium*

Subgenus 2.—Lepidodermopsis. Sporangium-wall cartilaginous.

Stalk and columella orange or orange-brown ; sporangium-wall areolated, orange-brown. 17. *D. leoninum*

1. **D. difforme** Duby Bot. Gall., ii. 858 (1830) (*dis* away, *forma* shape, of unusual shape). Plasmodium colourless or yellow. Sporangia scattered, pulvinate on a broad base or forming plasmodiocarps, 0·4 to 2 mm. or more long, smooth, white ; sporangium-wall of two layers, the outer a thin eggshell-like crust of densely combined minute crystals of lime, separating from the iridescent membranous inner layer, which is purplish or colourless above, yellowish-brown and thickened at the margin. Floor of sporangium an orange or purplish membrane with scanty deposits of small lime crystals. Capillitium rather scanty, consisting of coarse or slender, purple or colourless flattened threads, usually broad at the base, branching dichotomously and slender above. Spores dark purple-brown or purplish grey, very faintly and closely warted, with a pale area of dehiscence, 11 to 14 μ diam. ; marked when dry with branching ridges or wrinkles which disappear when the spore-contents have swelled in water.—Torrend Fl. Myx., 149 ; Macbr. N. Am. Slime-Moulds, ed. 2, 126. *Reticularia angulata* Pers. in Gmel. Syst. Nat.,

1472 (1791) ? *Diderma difforme* Pers. Disp. Meth., 9 (1797). *D. cyanescens* Fr. Syst. Myc., iii. 109 (1829). *D. liceoides* Fr. l.c., 107 ? *D. nitens* Klotzsch in Sm. Engl. Fl., v., pt. 2, 311 (1836). *D. Neesii* Corda Icon., ii. 23. *D. Libertianum* Fres. Beitr. Myk., 28, tab. iv, figs. 16 to 27 (1850). *D. Persoonii* Macbr. N. Am. Slime-Moulds, 96 (1899). *Licea caesia* Schum. Enum. Pl. Saell., ii. 219 (1803). *L. alba* Nees in Kunze & Schmidt Myc., ii. 66 (1823). *L. macrospora* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 258 (1832). *Amphisporium versicolor* Link in Mag. Ges. Nat. Fr. Berl., vii. 41 (1813). *Didymium cyanescens* Fr. Symb. Gast., 19 (1817). *D. Libertianum* de Bary Mycetozoa, 124 (1864). *Reticularia pusilla* Fr. Syst. Orb. Veg., i. 147 (1825). *Leocarpus cyanescens* Fr. Summ. Veg. Scand., 450 (1849). *Physarum difforme* Link l.c., iii. 27 (1809). *P. album* Fr. Syst. Myc., iii. 147. *P. caesium* Fr. l.c. *Lycogala minutum* Grev. Scot. Crypt. Fl., t. 40 (1823). *Chondrioderma difforme* Rost. in Fuckel Symb. Myc., Nachtr., 73 (1873), & Mon., 177 ; Lister in Ann. Bot., iv. 281 ; Mass. Mon., 212. *C. liceoides* Rost. l.c., App. 17 (1876) ; Mass. l.c., 215.

Var. **comatum** Lister in Journ. Bot., xxxix. 8 (1901) (having a head of hair). Capillitium profuse, of slender straight branching threads, not thicker below, dark or colourless ; spores purplish-grey.—*Leocarpus calcareus* Link in Mag. Ges. Nat. Fr. Berl., iii. 26 (1809) ? *Diderma chalybeum* Weinm. Hymeno-Gastero-myc., 592 (1836) ? *Chondrioderma calcareum* Rost. in Fuckel Symb. Myc., Nachtr., 74 (1873) ?

Var. **repandum** G. Lister in l.c., lix. 91 (1921) (broad). Plasmodiocarps broad or sinuous, or forming a flat perforated plate. Capillitium as in the typical form, but with tubular or funnel-shaped ingrowths connecting the roof with the floor of the sporangium often present. Spores 14 to 15 μ.—*Didymium tubulatum* Jahn in Ber. Deutsch. Bot. Ges., xxxvi. 663, tab. xviii, figs. 1–3 (1919).

Pl. 104.—*a*. sporangia (Lyme Regis) ; *b*. capillitium and spores, with a fragment of the upper and lower sporangium-wall ; *c*. capillitium and spores of var. *comatum* ; *d*. spore of type.

This species is removed from *Chondrioderma* (syn. *Diderma*) where it was placed by Rostafinski, on account of the crystalline character of the lime forming the outer crust of the sporangium-wall. The type of *Licea macrospora* Schwein. from Carolina (K. 1206), named *Chondrioderma liceoides* by Rostafinski, is a characteristic specimen of the present species. The var. *comatum* appears abundantly throughout the winter months in the neighbourhood of Lyme Regis and proves to be widely distributed ; it has profuse capillitium, the plasmodiocarps are often larger and more plate-like, and the spores greyer than in the typical form, but these characters are not constant. There is no type of *Chondrioderma calcareum* Rost. in the quoted collections ; the description in Rostafinski's monograph, however, applies well to the var. *comatum* of *D. difforme*.* The var. *repandum* is a con-

* The description of *C. calcareum* Rost. in Saccardo's Sylloge, vii. 370, is contracted, and omits any reference to the abundant development of the capillitium.

spicuous and not unfrequent form, usually characterized by the presence of colourless or orange processes, tubular below, funnel-shaped above, penetrating the sporangium and connecting the upper and lower walls; the capillitium is typical, consisting of colourless threads, stout below and branching repeatedly upwards to end in slender branchlets; the spores are rather larger than usual, but are otherwise typical. This form is well described and illustrated by Dr. Jahn under the name *D. tubulatum* n. sp.: unfortunately his account did not come to hand till after the varietal name *repandum* had been published.

Hab. On dead leaves and decaying herbaceous stalks: very abundant in England, especially in the southern counties, throughout the year; less common in the north and in Scotland; widely distributed in the British Isles, Europe, and in all temperate regions: var. *comatum* recorded from Cornwall, Devon, Somerset, Bedfordshire, Aberdeenshire, Co. Down, Japan, and Pennsylvania: var. *repandum* from Sussex, Surrey, Hertfordshire, Bedfordshire, Norfolk, Yorkshire, Devon, and Germany.

2. **D. quitense** Torrend Fl. Myx., 150 (1909) (Quito, Ecuador). Plasmodium ? Sporangia scattered, sessile, hemispherical, depressed, 0·4 to 0·5 mm. diam., or forming long plasmodiocarps, smooth, white; outer sporangium-wall of small lime crystals combined to form a white, eggshell-like crust, separating from the membranous, pale purplish inner wall. Capillitium a network of rather stout purplish-brown straight or flexuose threads, equal in thickness throughout. Spores dark brownish-purple, 13 to 14 μ diam., marked with warts and ridges more or less united to form a close reticulation.—Macbr. N. Am. Slime-Moulds, ed. 2, 127. *Chondrioderma quitense* Pat. in Bull. Soc. Myc. Fr., xi. 212 (1895) ?

Pl. 218.—*f.–h.* spores.

Closely allied to *D. difforme* from which it differs in the dark network of the capillitium and in the uniformly dark spores being marked with an imperfect reticulation.

Hab. On dead leaves.—Ecuador and Colorado.

3. **D. trachysporum** G. Lister in Essex Naturalist, xx. 113, pl. ix (1922) (τραχύς rough, σπορά seed). Plasmodium colourless. Sporangia more or less scattered, white or cream-white, either hemispherical, 0·2 to 0·6 mm. diam., or forming slender curved simple, branched or ring-shaped plasmodiocarps; the outer wall a smooth or wrinkled crust of closely compacted lime-granules; inner wall membranous, colourless. Floor of sporangium pale yellow, membranous with a thickened margin, with scanty, rarely abundant deposits of lime-crystals. Capillitium rather scanty, variable, consisting usually of a network of colourless or purplish, stout or slender threads, sometimes with vesicular expansions enclosing lime-crystals. Spores brownish-purple, 9 to 10 μ diam., marked with short spines which are scattered or grouped in clusters, rarely marked with patches of broken reticulation; the spore-wall is often traversed by a low ridge.

Pl. 218.—*a.* plasmodiocarp with crust cracked and broken, and the base of a sporan-

gium showing a rudimentary columella; *b*, *c*, various forms of capillitium with spores and a fragment of the calcareous crust; *d*, *e*. spinose and reticulated spores.

This species is similar to *D. quitense* in general appearance, but is distinguished by the smaller, paler, spinose spores; from *D. dubium* it differs in the sporangia not being solitary, in the more scanty capillitium threads which are often stouter towards the base, and in the rougher spores; from sessile forms of the protean species *D. squamulosum* it may be distinguished partly by the smoother crust and absence of a definite columella, partly by the spinose spores; from *D. vaccinum* it differs in the sessile often depressed character of the sporangia whose external crust breaks away in fragments instead of falling off as a whole. It is sometimes very abundant in old straw-manure, where it may easily be overlooked as a form of *D. difforme*. Dr. Jahn has repeatedly had it appear in cultures on pellets of rabbit and deer, and on old bean-stalks.

Hab. On dead leaves and herbaceous stalks, old straw and straw-manure. —Essex, Surrey, Bedfordshire, Aberdeenshire, France, Germany, Austria.

4. **D. dubium** Rost. Mon., 152 (1875) (doubtful). Plasmodium watery white. Sporangia solitary, hemispherical, 0·5 to 1 mm. diam., or forming broad almost flat plasmodiocarps, 2 to 12 mm. across, 0·13 mm. thick; sporangium-wall of two layers, the outer consisting of an eggshell-like crust of closely combined large stellate crystals, often extending beyond the broad membranous base of the sporangium, and powdered with free crystals, the inner layer membranous. Columella none. Capillitium profuse, consisting of rigid, dark purplish-brown or pale threads, anastomosing chiefly above and below and attached by colourless slender branches to the sporangium-wall. Spores violet-grey, spinulose or nearly smooth, 8 to 15 μ diam.—Mass. Mon., 246; Macbride N. Am. Slime-Moulds, ed. 2, 126. *Didymium Listeri* Mass. l.c., 244 (1892).

Pl. 105.—*a*. sporangia (Lyme Regis); *b*, *c*. various forms of capillitium and spores, with crystals from the sporangium-wall; *d*. capillitium and spores of the type specimen from Hauenstein, Bohemia; *e*. spore.

This species may be distinguished in the field from *D. difforme* by the eggshell-like crust being powdered with loose crystals, while that of *D. difforme* is quite smooth and almost glossy. *D. dubium* is abundant on decaying leaves of holly and ivy in the neighbourhood of Lyme Regis. In many gatherings the spores are nearly smooth, measuring 8 to 10 μ diam., while in others they are spinulose, 12 to 15 μ diam.; the capillitium is occasionally flexuose with bead-like or irregular thickenings and with short free branches. Specimens submitted to Rostafinski were pronounced by him to differ from the original Hauenstein gathering in having smoother spores and more slender capillitium without thickenings; considering the variation mentioned above, these characters cannot be accepted as sufficient to mark the Lyme Regis form as a distinct species. This view is confirmed by inspection of part of the type which has kindly been presented to us by Dr. Čelakovsky, jun.

Hab. On dead leaves: recorded from Devon, Dorset, Somerset, Hampshire, Sussex, Surrey, Nairnshire, Bohemia, Bermuda, Iowa.

5. **D. vaccinum** Buchet in Bull. Soc. Myc. Fr., xxxvi. 110 (1920) (*vacca* cow). Plasmodium bright buttercup-yellow.

Sporangia scattered, hemispherical or top-shaped, 0·6 to 1 mm. diam., shortly stalked or sessile, rarely forming plasmodiocarps, smooth, cream-coloured or white; sporangium-wall readily falling off entire and consisting of two layers; the outer brittle and shell-like, composed of closely compacted, angular or stellate crystals of lime, forming a hemispherical cap fitting on to the yellow-brown thickened margin of the large hemispherical columella; the inner layer membranous, usually adhering to the outer layer. Stalk obconical or shortly cylindrical, yellowish-brown, 0·2 to 0·4 mm. high, filled like the columella with stellate crystals of lime. Capillitium consisting of rigid and persistent colourless or purplish-brown nearly simple or branched threads, sometimes expanded below into membranous vesicles filled with lime-crystals. Spores brownish-purple, 9 to 12 μ diam., strongly warted, paler and the warts smaller on one side of the spore than the other; in irregular developments the warts may be replaced by small patches of close reticulation.—*Diderma vaccinum* Dur. & Mont. Expl. Sc. Alg., 407, tab. 22 *bis*, fig. 1 *a–h* (1846). *Chondrioderma vaccinum* Rost. Mon., 180 (1875). *Didymium Trochus* Lister in Journ. Bot., xxxvi. 164 (1898); Torr. Fl. Myx., 150.

Pl. 106.—*a*. sporangia; *b*. capillitium and spores with fragment of crust and of columella; *c*. spore.

This species occurs at all seasons in some years, and in great profusion, on old straw heaps, especially among the deeper moister layers. The type from Algiers, collected in 1840, was on decaying stems of *Opuntia*; it has been examined by M. S. Buchet, who finds it agrees in all respects with what has been known as *D. Trochus*. In Portugal the Rev. C. Torrend has collected it in some abundance on the old stumps and leaves of *Agave*.

Hab. On old straw and decaying fleshy leaves, &c.—Surrey, Sussex, Bedfordshire, Buckinghamshire, Norfolk, Portugal, Algeria, Japan.

6. **D. complanatum** Rost. Mon., 151 (1875) (*non* Schrad.) (levelled down). Plasmodium lemon-yellow. Sporangia forming scattered or solitary depressed plasmodiocarps, 2 to 8 mm. broad, 0·1 to 0·15 mm. thick, either effused, perforated and net-like, or vermiform, grey; sporangium-wall membranous, colourless, with scattered superficial stellate crystals of lime. Columella none. Capillitium consisting of very slender somewhat branching and anastomosing pale violet threads, connected with numerous subglobose vesicles 20 to 50 μ diam., filled with yellow obscurely granular matter. Spores pale violet-brown, minutely warted, 7 to 9 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 116. *Lycoperdon complanatum* Batsch Elench. Fung., i. 251 (1786)? *Physarum confluens* Pers. β *muscigenum* Alb. & Schw. Consp. Fung., 61 (1805)? *Didymium Serpula* Fr. Syst. Myc., iii. 126 (1829)?; Rost. l.c., App. 21; Lister Mycetozoa, 96.

Pl. 107.—*a*. plasmodiocarp (England); *b*. section of plasmodiocarp showing capillitium with large vesicles; *c*. capillitium and spores; *d*. spore.

No writers before Rostafinski make any mention of the characteristic

vesicles of the capillitium, and the references to Batsch and Fries quoted above might apply as well to plasmodiocarp forms of *D. squamulosum*, which *D. complanatum* often superficially resembles. The reference by Albertini & Schweinitz to the yellow plasmodium of *Physarum confluens β muscigenum* (l.c.) makes it probable that they were describing the present species in part at least. The drawing of the capillitium in Massee's Monograph (fig. 56) of *D. serpula* does not represent the characteristic vesicles, and the specimens from Kew, Batheaston, and Carlisle in his collection, quoted by him under this name (l.c. 234), are plasmodiocarp forms of *D. squamulosum*. These vesicles are frequently traversed by the capillitium threads, and are apparently formed later than the capillitium; like the spores, they are minutely warted.

Hab. On dead leaves and sticks: not uncommon in England and Wales, and widely distributed throughout Europe; recorded also from New York and Pennsylvania.

7. **D. Clavus** Rabenh. Deutsch. Krypt. Fl., i. 280 (1844) (nail). Plasmodium grey or colourless. Total height 0·4 to 0·8 mm. Sporangia scattered, disc-shaped, stalked, erect, 0·7 to 1 mm. diam., 0·2 mm. thick, greyish-white; sporangium-wall membranous, more or less spotted with reddish-brown, and with superficial clusters of stellate crystals of lime above, thickened and brown at the base. Stalk cylindrical, longitudinally striate, pale brown or black. Columella represented only by the thickened discoid base of the sporangium-wall. Capillitium profuse, consisting of sparingly branched colourless or purple-brown threads. Spores pale violet-brown, almost smooth, 5 to 8 μ diam.—Rost. Mon., 153; Mass. Mon., 230; Macbr. N. Am. Slime-Moulds, ed. 2, 122. *Physarum Clavus* Alb. & Schw. Consp. Fung., 96 (1805). *Reticularia hemispherica* Bull. Champ., 93, pl. 446, fig. 1 (1791), in part? *Didymium melanopus β Clavus* Fr. Syst. Myc., iii. 114 (1829). *D. hemisphericum* Fr. l.c., 115, in part? *D. commutabile* Berk. & Br. in Journ. Linn. Soc., xiv. 83 (1873); Rost. l.c., App. 21. *D. radiatum* Mass. l.c., 229 (1892), in part. *D. neglectum* Mass. (*non* Berk. & Br.) l.c., 231. *D. Masseeanum* Sacc. & Syd. Syll. Fung., xiv. 836 (1899).

Pl. 108.—*a*, *b*, sporangia (England); *c*, capillitium and spores with fragments of the upper and lower sporangium-walls; *d*, spore.

The type of *D. commutabile* Berk. & Br. from Ceylon (B.M. 537) is an unusually long-stalked form of the present species; the stalks measure 1·5 mm. and are encrusted with deposits of lime. The type of *D. neglectum* Mass., from Philadelphia, in Herb. Massee, is a slender form of *D. Clavus*.

Hab. On dead leaves and twigs, frequent in the British Isles throughout the year, and widely distributed in temperate and tropical regions; not common in the United States.

8. **D. melanospermum** Macbr. N. Am. Slime-Moulds, 88 (1899) (μέλας black, σπέρμα seed). Plasmodium colourless or grey. Total height 0·5 to 1 mm. Sporangia gregarious, subglobose or hemispherical, deeply umbilicate beneath, 0·7 to 1 mm. diam., either stalked or sessile, often confluent, white or grey; sporangium-wall firm, mottled with purple-brown,

and clothed with stellate crystals of lime. Stalk cylindrical from a broad base, striate, dark brown, rarely rufous, 0·2 to 0·7 mm. long, 0·05 to 0·2 mm. thick, opaque and granular from enclosed refuse-matter, sometimes containing crystalline nodules of lime. Columella large, hemispherical, umbilicate, dark brown, rarely whitish, chambered, containing irregular nodules of lime. Capillitium of stout sparingly branched or simple flexuose threads, colourless or purplish-brown, often showing dark calyciform thickenings. Spores dark purplish-brown or purplish-grey, with a thick spore-wall, nearly smooth or spinose, 9 to 12 μ diam.—*Physarum melanospermum* Pers. in Roemer N. Mag. Bot., 88 (1794). *P. farinaceum* Pers. Syn. Fung., 174 (1801). *P. cinerascens* Schum. Enum. Pl. Saell., ii. 199 (1803) ? *P. globosum* Schum. l.c., 203 ? *P. sinuosum* Link in Mag. Ges. Nat. Fr. Berl., iii. 27 (1809). *P. capitatum* Link l.c. *P. nigrum* Fr. Syst. Myc., iii. 146 (1829) ? *Didymium farinaceum* Schrad. Nov. Gen. Pl., 26, t. 5, fig. 6 (1797) ; Rost. Mon., 154 ; Mass. Mon., 219 ; Lister Mycetozoa, 97. *D. complanatum* Schrad. l.c., 24, t. 5, fig. 5 ? *D. lobatum* Nees Syst., 112 (1816) ? ; Fr. l.c., 123. *D. physaroides* Fr. Symb. Gast., 21 (1818) ; Rost. l.c., 158 ; Mass. l.c., 233. *D. melanopus* Fr. Syst. Myc., iii. 114 ? *D. Fairmani* Sacc. in Journ. Myc., (1889) 79, & Fairman Contr. Myc. West N.Y., 52, t. iii., figs. 7 to 9. *Trichia compressa* Trentep. in Roth Catal. Bot., i. 229 (1797). *T. depressa* Trentep. l.c., 231. *T. globosa* Vill. Fl. Dauph., 1061 (1789). *T. sphaerocephala* Sow. Engl. Fung., t. 240 (1799). *T. farinosa* Poiret in Lam. Encycl., viii. 53 (1808). *Spumaria physaroides* Pers. l.c., 163 ? *Strongylium minus* Fr. Symb. Gast., 9 (1817). *Cionium farinaceum* Link Handb., iii. 410 (1833). *C. lobatum* Spreng. Syst. Veg., iv. 529 (1827). *C. complanatum* Link ex Wallr. Fl. Crypt. Germ., ii. 365 (1833) ?

Var. **minus** Lister l.c. (less). Threads of capillitium slender ; spores 7 to 9 μ diam.—*D. humile* Hazsl. in Oester. Bot. Zeitschr., xxvii. 84 (1877). *D. minus* Morg. in Journ. Cinc. Soc. Nat. Hist., xvi. 145 (1894) ; Macbr. l.c., ed. 2, 121.

Var. **bicolor** G. Lister (two-colours). Columella and upper part of stalk nearly white from enclosed calcareous deposits.

Pl. 112.—*a*. sporangia (England) ; *b*. capillitium and spores with fragment of sporangium-wall ; *c*. spore ; *d*. sporangia of var. *minus* (England) ; *e*. capillitium and spores of same ; *f*. spore.

Intermediate forms uniting the var. *minus* and the typical form are so frequent that the former cannot be regarded as a distinct species ; it is, however, fairly constant in its characters being distinguished by the smaller sporangia and more slender capillitium ; it often bears a considerable resemblance to *D. nigripes*, but differs in the short opaque stalks. In the var. *bicolor* the upper part of the stalk as well as the columella is white or pale brown and filled with crystalline nodules of lime. Rostafinski's specimen of *D. physaroides* in the Strasb. Herb. is an imperfect development of *D. melanospermum* ; the spores are combined in agglutinated masses,

and the capillitium contains vesicular expansions filled with lime such as occur in imperfect growths of *Didymium* ; the sporangia are mostly clustered and confluent, but in some cases they are solitary.

Hab. On dead wood, twigs, and leaves, especially of Conifers : both the typical form and var. *minus* are frequent in the British Isles and are widely distributed in temperate regions ; they appear to be less common in the tropics : var. *bicolor* has been recorded from Wales, Java, Japan, and Bermuda.

9. **D. nigripes** Fries Syst. Myc., iii. 119 (1829) (*niger* black, *pes* foot). Plasmodium grey or colourless. Total height 1 to 1·5 mm. Sporangia gregarious, hemispherical, umbilicate beneath, stalked, erect, 0·5 to 0·7 mm. diam., white ; sporangium-wall membranous, mottled with brown or colourless, clothed with stellate crystals of lime. Stalk cylindrical, two to three times the height of the sporangium, longitudinally striate, varying in colour from dark olive to orange-brown, translucent, not containing refuse-matter. Columella subglobose, dark brown, filled with irregular angular crystals of lime. Capillitium of delicate colourless or purplish-brown branching threads. Spores pale violet-brown, nearly smooth, 8 to 11 μ diam.—Berk. in Sm. Engl. Fl., v., pt. 2, 313 ; Macbr. N. Am. Slime-Moulds, ed. 2, 123. *Physarum nigripes* Link in Mag. Ges. Nat. Fr. Berl., iii. Diss. 1, 27 (1809) ; Ditm. in Sturm Deutsch. Fl., Pilze, iii. 85, t. 42. *P. microcarpon* Fr. Symb. Gast., 23 (1818). *Didymium microcephalum* Chev. Fung. & Byss. Ill., fig. 2 (1837). *D. porphyropus* Dur. & Mont. Fl. Alg., 409 (1846). *D. microcarpon* Rost. Mon., 157 (1875) ; Mass. Mon., 226. *D. tenue* Pat. in Bull. Soc. Myc., iv. 96 (1888).

Var. **eximium** Lister Mycetozoa, 98 (1894) (notable). Stalk dark orange, columella orange or buff ; sporangium-wall firm, usually buff.—Sturgis in Tr. Conn. Acad. Arts Sc., x. 478. *D. megalosporum* Berk. & Curt. in Grev., ii. 53 (1873) ; see Sturgis in Mycologia, viii. 201 (1916). *D. eximium* Peck in Rep. N. York Mus., xxxi. 41 (1879) ; Macbr. l.c., 124. *D. fulvellum* Mass. l.c., 237 (1892).

Var. **xanthopus** Lister l.c. (ξανθός yellow, πούς foot). Stalk orange, columella white.—*Cionium xanthopus* Ditm. l.c., 87, t. 43. *C. iridis* Ditm. l.c., 13, t. 7. *Diderma lobatum* Somm. Suppl. Fl. Lapp., 240 (1826) ? *Didymium xanthopus* Fr. Syst. Myc., iii. 120 (1829) ; Macbr. l.c., 123. *D. iridis* Fr. l.c., 120. *D. lobatum* var. *stipitatum* Fr. l.c., 123 ? *D. pertusum* Berk. l.c., 313 ; Mass. l.c., 241. *D. proximum* Berk. & Curt. in Grev., ii. 52 (1873) ; Rost. l.c., App. 23. *D. elegantissimum* Mass. l.c., 243.

Pl. 102.—*a.* sporangia (England) ; *b.* capillitium and spores with fragment of sporangium-wall ; *c.* spore ; *d.* sporangia of var. *eximium* (Mexico) ; *e.* sporangia of var. *xanthopus* ; *f.* capillitium and spores of same ; *g.* spore of same (England).

The above varieties have been distinguished by specific names, depending

on the colour of the stalk, columella, and capillitium. The capillitium may vary, however, from white to purplish-brown in the same group of sporangia, and the colour of the stalk and columella is also inconstant. The specimen B.M. 885, from Ravenel, South Carolina, is intermediate between the typical form and the var. *eximium*, having some sporangia with dark brown and others with deep orange stalks and columellae on the same leaf. *D. eximium* Peck and *D. fulvellum* Mass. have orange-red stalks, with the columellae orange or buff. The type of *D. proximum* Berk. & Curt. from South Carolina (K. 1493) has orange-red stalks and a pale buff columella. The type of *D. pertusum* Berk. from Appin, N.B. (K. 463) has orange stalks and a white columella ; it corresponds with the description of *D. xanthopus* Fries in all essential characters. *D. elegantissimum* Mass. from Charlottenburg (K. 1) is the same variety. These forms blend into one another so completely that they are here united under *D. nigripes*. In this species the upper part of the stalk as well as the columella occasionally contains crystals of lime, as in *D. melanospermum*.

Hab. On dead leaves and twigs : the typical form and var. *xanthopus* are abundant in the British Isles and in temperate and tropical regions ; var. *eximium* is less common, but widely distributed.

10. **D. squamulosum** Fries Symb. Gasterom., 19 (1818) (scaly). Plasmodium colourless. Sporangia gregarious, subglobose or hemispherical, umbilicate beneath, 0·5 to 1 mm. diam., stalked, sessile, or forming effused plasmodiocarps, either snow-white from abundant stellate crystals, which often form a wrinkled deciduous scaly outer crust, or grey when the crystals are more scanty ; in the plasmodiocarp forms the crystals are often sparsely distributed ; sporangium-wall membranous, sometimes mottled with red-brown towards the base, at length breaking up into small fragments. Stalk white or pale yellow, rarely orange, cylindrical, deeply furrowed, rough with deposits of lime in minute crystals in the walls, varying much in length, spreading at the base into a white discoid hypothallus. Columella large or small, white or yellowish, hemispherical, absent in effused plasmodiocarps. Capillitium variable, of slender or coarse threads, either almost simple or branching at an acute angle, colourless, violet, or purplish-brown, often with dark calyciform thickenings. Spores violet-brown, 8 to 11 μ diam., faintly or distinctly spinulose, the spinules often grouped in clusters.—Fr. Syst. Myc., iii. 118 ; Rost. Mon., 159 ; Mass. Mon., 223 ; Macbr. N. Am. Slime-Moulds, ed. 2, 119. *Trichia rugosa* Trentep. in Roth Cat. Bot., 228 (1797). *T. sphaerica* Trentep. l.c., 230. *T. pedicellata* Poiret in Lam. Encycl. Suppl., v. 373 (1817). *Diderma squamulosum* Alb. & Schw. Consp. Fung., 88 (1805). *Licea stipitata* DC. Fl. Fr., ed. 2, 101 (1815). *Didymium effusum* Link in Mag. Ges. Nat. Fr. Berl., 42 (1815) ; Rost. l.c., 163 ; Lister Mycetozoa, 99. *D. herbarum* Fr. l.c., 120. *D. leucopus* Fr. l.c., 121. *D. costatum* Fr. l.c., 118. *D. filamentosum* Wallr. Fl. Crypt. Germ., ii. 368 (1833) ? *D. radiatum* Berk. & Curt. in Journ. Linn. Soc., x. 348 (1869) ;

Mass. l.c., 229, in part. *D. neglectum* Berk. & Br. in Journ. Linn. Soc., xiv. 83 (1873). *D. Fuckelianum* Rost. in Fuckel Symb. Myc., ii. 73 (1873); Mon., 161 (1875). *D. praecox* de Bary in Rab. Fung. Eur., no. 367 (1861); Rost. l.c., 163. *D. macrospermum* Rost. l.c., 161. *D. discoideum* Rost. l.c., 162. *D. confluens* Rost. l.c., App. 22 (1876). *D. platypus* Hazsl. in Oester. Bot. Zeitschr., xxvii. 83 (1877) ? *D. angulatum* Peck in Rep. N. York Mus., xxxi. 41 (1879). *D. Cookei* Raunk. in Bot. Tidssk., xvii. 86 (1888). *D. Bonianum* Pat. in Journ. de Bot., v. 316 (1891). *D. anomalum* Mass. l.c., 245 (1892) ? *D. Tussilaginis* Mass. l.c., 244. *D. affine* Raunk. l.c., 88, t. v, figs. 3, 4. *Physarum confluens* Pers. Syn. Fung., 169 (1801) ?; Fr. l.c., 146, in part ? *P. alatum* Fr. l.c., 132 ? *P. liceoides* Duby in DC. Bot. Gall., ed. 2, ii. 461 (1830). *P. Tussilaginis* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 4, xvii. 139 (1876). *Cionium squamulosum* Spreng. Syst. Veg., iv. 529 (1827). *Chondrioderma anomalum* Rost. Mon., 169 ? *C. Cookei* Rost. l.c., App. 17 (1876). *C. leptotrichum* Racib. in Rozpr. Mat. Przyr. Acad. Krak., xii. 75 (1884) ?

Var. **claviforme** Sturgis in Colo. Coll. Publ., Sc. Ser., xii. 27 (1907) (*clavis* nail, *forma* shape). Sporangia disc-shaped, umbilicate above and beneath; stalk 0·3 to 0·5 mm. long, columella hemispherical or depressed.—*Didymium annulatum* Macbr. l.c., 125 (1922) ?

Pl. 109.—*a*. sessile sporangia, one is broken and shows the white columella (England); *b*. stalked sporangia; *c*. plasmodiocarp form without columella; *d*. sporangium with wrinkled crust (Devon); *e*. spore of same, marked with clustered warts; *f*, *g*, *h*. capillitium and spores of various forms, with crystals from sporangium-wall; *i*. spore of the usual form.

The numerous varieties which occur in this common and widely distributed species have led to different forms receiving specific rank. Observations conducted for a length of time on large growths among one heap of leaves show that the colour of the capillitium varies from almost black to colourless in the same locality; a cluster on one leaf may present several shades, and even in a single sporangium one-half of the capillitium may be dark and the other half colourless; this difference of colour is seen in all forms, from the stalked sporangia to effused plasmodiocarps. The stalk and columella may vary from white to bright orange. The spinules on the spores are sometimes minute, sometimes rather strongly developed, and are either regularly distributed or grouped in a few large or small clusters when they may give a crested appearance to the spore outline; such a form is often seen in developments on decaying holly leaves in this country, and is usually associated with a much wrinkled crust of lime-crystals. The characters distinguishing *D. effusum* Link, *D. macrospermum* Rost., *D. discoideum* Rost., *D. praecox* de By., and *D. Fuckelianum* Rost. are so inconstant that they cannot be applied to mark even varieties of *D. squamulosum*. In the specimen marked *D. effusum* Rost. in Strasb. Herb., the sporangia are stalked and sessile, with slender white capillitium; in the sporangium examined the threads in one portion are without any thickenings; in the remaining part there are numerous small fusiform expansions containing lime, an irregular development not unfrequent in this species; the spores are minutely spinulose. The specimen of *D. macrospermum* in

Strasb. Herb. has colourless capillitium springing from a large white columella ; the spores are strongly spinulose, 10 to 11 μ diam. The type of *D. praecox* is a form of the present species with the crust of crystals on the sporangium-wall wrinkled and scaly. *D. discoideum* and *D. Fuckelianum* are distinguished by the stalk and columella being yellow or pale brown and by the spotted membrane of the sporangium-wall ; these characters are met with in different degrees in *D. squamulosum*, associated with sporangia having white stalks and colourless walls and capillitium. The type of *D. radiatum* Berk. & Curt. from Cuba (K. 1516) is nearly destroyed ; only the stalks remain, but these are characteristic of the present species, being white, deeply furrowed, granular with deposits of lime, and arising from a discoid base. *Chondrioderma Cookei* Rost., on leaves of *Tussilago* (B.M. 137), is a sessile form of the present species ; the capillitium is an irregular network of dull violet threads, with expansions containing nodules of lime such as are of frequent occurrence in imperfect developments both in this species and its allies.

Hab. On dead leaves, straw, &c. : widely dispersed, and one of the most abundant species in temperate and tropical climates.

11. **D. anomalum** Sturgis in Colo. Coll. Publ., Sc. Ser., xii. 444, Pl. 2, figs. 6–8 (1913) *non* Massee (irregular). Plasmodium ? Sporangia forming very thin dull grey effused plasmodiocarps, often wrinkled and minutely pitted on the surface, 1 mm. to several centimetres long ; sporangium-wall membranous, hyaline or yellowish, with scanty deposits of small irregular lime-crystals. Columella none. Capillitium consisting of tubular columns enclosing small irregular lime-crystals and often refuse-matter, connecting the upper wall of the plasmodiocarp with the base. Spores violet-brown, 10 to 12 μ diam., marked with very minute warts which are usually arranged in clusters.—Macbr. N. Am. Slime-Moulds, ed. 2, 127.

Pl. 210.—*a*. plasmodiocarp perforated in the centre ; *b*. spores and capillitium, showing attachment of tubes to upper and lower sporangium-wall ; *c*. spore.

This species is unique in the genus in the capillitium consisting of a number of little tubular pillars connecting the roof with the floor of the plasmodiocarp, and enclosing calcareous matter in the form of irregular crystals ; it appears to be thoroughly constant in character. Besides the original gathering made by Dr. Sturgis near Colorado Springs in 1911, it was found by Mr. H. Bilgram near Philadelphia in 1919, and by the Rev. P. J. Alexander in abundance at Weybridge, Surrey, in the autumn of 1922.

Hab. On dead leaves, bark, and sticks.—Surrey ; Pennsylvania and Colorado.

12. **D. anellus** Morgan in Journ. Cinc. Soc. Nat. Hist., xvi. 148, t. xii. fig. 41 (1894) (little ring). Plasmodium colourless. Sporangia scattered, sessile, pulvinate or orbicular, umbilicate above, 0·3 to 0·5 mm. diam., often forming slender plasmodiocarps elongated into links and chains, grey, or glossy brown from absence of lime ; sporangium-wall membranous, colourless or purplish-brown, with sparse deposits of minute crystals of lime, at length dehiscing in a circumscissile manner. Columella none. Capillitium abundant, consisting of slender

flexuose violet-brown threads, simple or somewhat branched and anastomosing. Spores purplish-grey or purplish-brown, minutely spinulose, 7 to 12 μ diam.—Petch in Ann. Perad., iv. 349; Macbr. N. Am. Slime-Moulds, ed. 2, 117. *D. effusum* var. *tenue* Lister in Journ. Bot., xxxv. 214 (1897).

Pl. 110.—*a*. sporangia (Essex); *b*. capillitium and spores with fragment of sporangium-wall; *c*. spore.

This species, though closely resembling slender plasmodiocarp forms of *D. squamulosum*, appears to retain the distinctive circumscissile mode of dehiscence and the centrally depressed sporangia.

Hab. On dead leaves.—Essex, Surrey, Bedfordshire, Worcestershire, Yorkshire, Ceylon, Bengal, Ohio, Colorado.

13. **D. Wilczekii** Meylan in Bull. Soc. Vaud. Sci. Nat., xliv. 290 (1908) (Prof. E. Wilczek, of Lausanne University). Plasmodium grey. Sporangia scattered, forming elongated curved or almost net-like plasmodiocarps, 1 to 2 mm. wide, 1 mm. to 3 cm. long, 0·3 to 0·5 mm. thick, white, smooth or scaly, or glossy brownish-purple when without lime; sporangium-wall dehiscing irregularly, membranous or somewhat cartilaginous, colourless, mottled with yellow or pale purplish, with a crust formed of minute stellate, rod-shaped, or nodular crystals of lime; the crust is often broken up into numerous discoid or concave scales, 0·1 to 0·2 mm. diam., each scale being attached by the centre to the membranous layer. Columella convex or represented by the colourless or yellowish-brown base of the sporangium-wall, which is usually thickened beneath with a network of strands containing a few minute lime-crystals. Capillitium abundant, consisting of pale brownish-purple often slender threads combined to form an elastic network, readily separating from the sporangium-walls. Spores purple-brown, minutely or strongly and closely spinulose, 9 to 17 μ diam.

Pl. 194.—*a*, *b*. plasmodiocarps (Jura Mountains); *c*. capillitium with fragments of sporangium-walls; *d*. spore.

This alpine species resembles the stouter plasmodiocarp forms of *D. squamulosum*, from which it is distinguished by the absence of a prominent columella, the dense elastic network of capillitium and the darker spores. It appears, often in great abundance, on open ground in the Jura Mountains and over the Swiss Alps at an altitude of 1,100 to 2,000 m. after the winter snows have melted; the sporangia are fugacious, and a shower of rain is sufficient to wash them away. Dr. R. E. Fries has gathered this species in subalpine situations near Frostviken, Jämtland, Sweden; the long stout plasmodiocarps either have lime deposits in the form of minute rod-shaped crystals, or are entirely without lime; the capillitium threads are stout and dark; the whole growth so closely resembles the sporangia of *Lepidoderma Carestianum* often found associated with it on the same twigs and herbage, that in writing to Dr. Fries we first thought that his specimens might be a '*Didymium* form' of the latter species (see R. E. Fries in Ark. Bot., vi. No. 7, 3 (1906), and Lister in Journ. Bot., xlvi. 218 (1908)). The affinity between *D. Wilczekii* and *Lepidoderma Chailletii* seems to be close, and, when, in the present species, the calcareous crust is replaced by small scales,

the resemblance to *L. Chailletii* may be puzzling in the field. Amongst large gatherings from Arosa, Vallais, on dead scapes of *Cirsium spinosissimum* and *Aconitum*, a specimen occurred in which the capillitium consists of pale and nearly simple threads marked throughout with one to three close spiral bands, a unique feature in the capillitium of any of the *Amaurosporales*.

Hab. On dead herbaceous stalks, turf, and twigs near melting snow in alpine regions.—Switzerland, Sweden, Colorado.

14. **D. crustaceum** Fries Syst. Myc., iii. 124 (1829) (*crusta* crust). Plasmodium white. Sporangia globose, confluent, clustered or scattered, shortly stalked or sessile, 0·7 to 2 mm. diam., smooth and white from the thick fragile deciduous crust of loosely compacted crystals of lime in which they are enclosed; when the crust has fallen away the sporangia appear reniform or hemispherical and grey; sporangium-wall membranous, colourless, clothed with large stellate crystals of lime. Stalks pale buff, 0·2 to 0·4 mm. high, slender, membranous, eight or ten often clustered together on an expansion of the membranous hypothallus, at first concealed under the crust of lime enclosing the group of sporangia. Columella small, irregular, depressed, scarcely evident in the sessile forms, white or pale buff, with rather scanty deposits of lime in the form of nodules. Capillitium consisting of colourless or pale violet branching threads 0·5 to 1 μ diam., often with minute fusiform thickenings. Spores purplish-grey, strongly spinulose, 10 to 13 μ diam.—Rost. Mon., App. 22; Macbr. N. Am. Slime-Moulds, ed. 2, 118. *D. confluens* Rost. Mon., 164 (1875); Mass. Mon., 235.

Pl. 111.—*a*. sporangia (Devon); *b*. cluster of sporangia from which the outer crust of lime has fallen away; they arise from a common hypothallus, in one the wall and capillitium are gone and the columella is exposed; *c*. capillitium and spores with crystals from the outer crust, also a portion of the columella with three nodules of lime; *b*. spores.

This widely distributed species is allied on the one hand to *D. squamulosum* and on the other to *Mucilago spongiosa*. The nomenclature given by Rostafinski of earlier date than that of Fries is very uncertain, and may apply equally well or better to other species.

Hab. On dead leaves and grass, not common.—Dorset, Devon, Somerset, Hampshire, Surrey, North Wales, Poland, Moldavia, Japan, Iowa, Dakota, Colorado.

15. **D. intermedium** Schroet. in Hedwigia, xxxv. 209 (1896). Plasmodium ? Sporangia gregarious or clustered, stalked, discoid, convex above, widely and deeply umbilicate beneath, often lobed or sinuous, 0·5 to 1 mm. diam., greyish white; sporangium-wall membranous, clothed with superficial deposits of lime-crystals. Stalk 0·7 to 1 mm. long, yellowish-white or buff, smooth, broad at the base and tapering upwards, filled, like the columella, with crystalline nodules of lime. Columella convex, discoid, pale yellow or white, formed by a shallow thickening of the base of the sporangium-wall,

recurved at the margin owing to the deeply umbilicate character of the sporangium. Capillitium of simple or branched slender colourless threads. Spores dark purple-brown, 9 to 12 μ diam., marked with a close irregular reticulation of minute ridges making a border about 0·7 μ deep.—*D. excelsum* Lister *ex* Jahn in Ber. Deutsch. Bot. Gesell., xx. 275, t. xiii, figs. 5 to 10 (1902).

Pl. 110.—*d.* sporangia, two have the walls and capillitium broken away exposing the columella; *e.* capillitium and spores; *f.* spore (Brazil).

This species has been obtained twice near Blumenau, Brazil, first by E. Ule in April, 1888, and later by Dr. A. Möller; Mr. K. Minakata writes that it was found on Mt. Nikko, Japan, in 1922 by Mr. Rokun. It is allied to *D. squamulosum*, from which it is distinguished by the shape of the sporangia, the structure of the stalk, and the markings of the spores which closely resemble those of *Mucilago spongiosa* var. *dictyospora*.

Hab. On herbaceous stems.—Brazil and Japan.

16. **D. fulvum** Sturgis in Mycologia, ix. 327, Pl. 14, figs. 4–6 (1917) (tawny). Plasmodium ? Sporangia in clusters, usually sessile, subglobose, concave beneath, 0·5 to 0·8 mm. diam., or forming curved plasmodiocarps, pale tawny from an abundant covering of yellowish lime-crystals; sporangium-wall membranous, spotted with orange-yellow, clothed with large sharp-pointed crystals of lime. Stalk, when present, short, orange, enclosing lime-crystals and merging into strands of tawny hypothallus which are rough with crystalline deposits. Columella either conical or almost obsolete, orange, enclosing lime-crystals. Capillitium an abundant network of purplish threads, hyaline at the extremities. Spores purplish-brown, closely warted, or marked with curved branching lines, paler and smoother on one side, 12 to 14 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 118.

Pl. 221.—*a.* group of sporangia; *b.* sporangium with spores dispersed, showing columella and capillitium; *c.* spores, and capillitium, showing attachments to columella and sporangium-wall; *d.* spore.

This species was found in some abundance by Dr. Sturgis, in August 1913, in Wet Mountain Valley, Colorado, a locality he has found to be prolific in Mycetozoa. It seems to be most nearly allied to *D. leoninum*, but differs in the membranous, not cartilaginous, sporangium-walls and in the large dark spores.

Hab. On dead leaves and twigs.—Colorado.

17. **D. leoninum** Berk. & Br. in Journ. Linn. Soc., xiv. 83 (1873) (lion-like, from the tawny colour). Plasmodium orange-red. Sporangia scattered or loosely clustered, stalked, subglobose, 0·6 to 0·7 mm. diam., either dark purplish-brown and glossy, broadly veined with white or buff deposits of lime, or pale all over from being completely clothed with lime-crystals; sporangium-wall at length breaking up into fragments, cartilaginous, chestnut-brown with thinner yellow lines of dehiscence (when seen by transmitted light); crystals of lime large, stellate. Stalks yellow, orange, or brown, 0·4 to

0·6 mm. high, often connected at the base by a vein-like hypothallus, of spongy consistency within, and, like the columella, usually charged with nodular crystals of lime. Columella subglobose, orange. Capillitium consisting of slender purple-brown threads, branched and anastomosing, colourless at the extremities. Spores violet-grey, 7 to 9 μ, minutely warted all over; about nine warts can be counted in a row across the hemisphere.—Petch in Ann. Perad., iv. 350. *Lepidoderma tigrinum* Rost. Mon., App. 23 (1876), in part; Lister Mycetozoa, 106, in part; Penzig Myx. Buit., 51. *Lepidodermopsis leoninus* v. Höhnel in Sitzungsber. k. Akad. Wiss. Wien, Math.-Nat. Kl., I. cxviii. 439, fig. 35 (1909).

Pl. 113.—*a.* sporangia (Ceylon); *b.* sporangia after the capillitium and spores have fallen away, showing the columellae; *c.* capillitium and spores, with fragment of columella and sporangium-wall with crystals of lime; *d.* spore.

This handsome species is closely allied to *Lepidoderma tigrinum*, which it resembles in the cartilaginous sporangium-wall, and in the structure of the orange stalk and columella; it differs in the sporangia being clothed with stellate crystals of lime, as in other *Didymia*, in the wall at length breaking up into areolae, and in the paler smaller spores.

Hab. On dead leaves.—Ceylon, Singapore, Java, Japan.

Genus 15.—**MUCILAGO** Adanson Fam. Pl., ii. 7 (1763) (Mod. Latin, mucilage). The sporangia are confluent to form an aethalium, otherwise the characters are those of the genus *Didymium*.—*Spumaria* Pers. in Gmel. Syst. Nat., ii. 1466 (1791).

1. **M. spongiosa** Morgan in Bot. Gaz., xxiv. 56 (1897) (spongy). Plasmodium white or yellow. Aethalia composed of elongated compressed lobed and branched grey sporangia, arising in loose or compact clusters from branching strands of the membranous hypothallus, clothed with a thick fragile deciduous universal covering of crystals of lime; 2 to 6 cm. long, 1 to 6 cm. wide, and about 1 cm. thick; sporangium-wall membranous, colourless or purplish. Columella membranous, hollow, compressed, sometimes absent. Capillitium a network of widely branching anastomosing stout purplish-brown or colourless threads, often with dark calyciform thickenings, hyaline at the extremities; the sporangia are sometimes penetrated by tubular processes which open externally, and either perforate the lobes of the sporangia or are continued into the capillitium threads. Spores dull purple, strongly spinulose, 10 to 13 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 114. *Mucor spongiosus* Leysser Fl. Hal., 305 (1783). *Reticularia alba* Bull. Champ., 92, t. 326 (1791). *Spumaria Mucilago*, Pers. Gmel. Syst. Nat., 1466 (1791). *S. cornuta* Schum. Enum. Pl. Saell., ii. 195 (1803). *S. alba* DC. Fl. Fr., ii. 261 (1805); Fr. Syst. Myc., iii. 95; Rost. Mon., 191; Lister

Mycetozoa, 104. *Didymium spumarioides* Fr. l.c., 121 (1829). *Diderma spumariaeforme* Wallr. Fl. Germ. Crypt., ii. 374 (1833).

Var. **dictyospora** R. E. Fr. in Arkiv. Bot., i. 66 (1903) (δίκτυον net, σπορά seed). Aethalia compact, irregularly effused or pulvinate ; lime-crystals small, nodular ; capillitium irregular, pale ; spores very dark, closely reticulated, 12 to 14 μ diam.

Var. **solida** Lister Mycetozoa, ed. 2, 138 (1911). Aethalia pulvinate, compact, 4 to 5 cm. diam., 1 to 2·5 cm. thick, lime-crystals small, often nodular ; capillitium scanty, colourless, irregular ; spores spinulose, 9 to 11 μ diam. *Spumaria alba* var. *solida* Sturgis in Colo. Coll. Publ., Sc. Ser., xii. 29 (1907). *S. solida* Jahn in Ber. Deutsch. Bot. Ges., xli. 391 (1923).

Pl. 117.—*a*. aethalium (England) ; *b*. cluster of sporangia from an aethalium ; in three places they are broken and show hollow columellae ; *c*. capillitium and spores, with crystals from the outer covering of lime ; *d*. spore ; *e*. spore of var. *dictyospora*.

This species is closely allied to *Didymium crustaceum*, but is distinguished by its aethalioid habit. In some seasons the cream-yellow plasmodium and large greyish-white aethalia form conspicuous features about the blades and stalks of grass in pastures, especially in autumn ; the report that they may then prove injurious to grazing cattle does not appear to rest on reliable evidence. The var. *dictyospora* was first gathered by Dr. R. E. Fries in Bolivia in 1902. It has since been found in some abundance on old straw in Bedfordshire, in close association with an equally compact form approaching var. *solida*, and with very dark warted or spinulose spores 12 to 14 μ diam. ; in the field the aethalia were hardly distinguishable from those of *Fuligo septica* var. *candida*. The var. *solida*, occurring usually on poplar bark, is a still more massive form, but is connected with the typical form by intermediate gatherings. In these compact forms the columellae are little developed or absent, and the capillitium is often represented by a network of flattened membranous tubes with wide expansions enclosing scattered lime-crystals.

Hab. On grass and dead leaves : abundant locally in Great Britain, and widely distributed in north temperate regions ; recorded also from Queensland : var. *dictyospora* recorded from Bedfordshire and Bolivia : var. *solida* on bark from near Berlin, Queensland, Kansas, and Colorado.

Genus 16.—**LEPIDODERMA** de Bary in Rost. Versuch, 13 (1873) (λεπίς scale, δέρμα skin). Sporangia stalked, sessile, or forming plasmodiocarps ; sporangium-wall cartilaginous, more or less clothed with apparently superficial crystalline discs or scales ; scales enclosed in pockets or vesicles of the sporangium-wall, but easily dislodged ; capillitium rigid and without lime (except in *L. Carestianum* var. *granuliferum*).

KEY TO THE SPECIES OF *LEPIDODERMA*.

Sporangia with orange walls and stalks. 1. *L. tigrinum*
Sporangia with pale yellow walls, usually sessile. 2. *L. Chailletii*
Sporangia forming plasmodiocarps with brownish-purple walls. 3. *L. Carestianum*

1. **L. tigrinum** Rost. Versuch, 13 (1873) (tiger-like). Plas-

modium orange-yellow. Sporangia scattered, subglobose, flattened and umbilicate beneath, stalked, rarely sessile, 1 to 1·5 mm. diam., olive- or purplish-grey, glossy, more or less closely covered with flat rounded, angular, or star-shaped crystalline scales of lime ; sporangium-wall cartilaginous, of two closely combined layers, orange-yellow. Stalk stout, cylindrical 0·2 to 0·7 mm. high, furrowed, orange-brown, of a spongy texture within, containing deposits of lime ; rising from a hypothallus which is either vein-like or effused and of a loose reticulated structure. Columella hemispherical, orange, of the same texture as the stalk, containing deposits of lime in rounded nodules. Capillitium profuse, of straight or flexuose threads, sparingly branched, dark purple-brown or grey. Spores dark purplish-grey, minutely and closely spinulose, 10 to 13 μ diam.—Rost. Mon., 187 ; Mass. Mon., 253 ; Macbr. N. Am. Slime-Moulds, ed. 2, 145. *Didymium tigrinum* Schrad. Nov. Gen. Pl., 22 (1797) ; Fr. Syst. Myc., iii. 117. *D. rufipes* Fr. l.c., 116 (1829). *D. versipelle* Fr. l.c., 117 ? *Physarum squamulosum* Pers. Syn. Fung., 174 (1801). *P. tigrinum* Pers. l.c. *Trichia squamulosa* Poiret in Lam. Encycl., viii. 53 (1808). *T. tigrina* Poiret l.c. *Leangium squamulosum* Fr. Stirp· Femsj., 83 (1827). *Diderma citrinum* Berk. in Sm. Engl. Fl., v. pt. 2, 310 (1836) (*non* Schum.). *Lepidoderma fulvum* Mass. l.c., 253 (1892).

Pl. 114.—*a*. sporangia (North Wales) ; *b*. capillitium and spores with fragment of sporangium-wall showing crystalline scales ; *c*. spore.

The species is not very common in England, but is abundant in pine woods in Aberdeenshire. Occasionally the scales on the sporangium-wall are replaced, in part at least, by deposits of minute angular lime-granules, like those of *Diderma ochraceum*, q.v. The specimens of *L. fulvum* from Scarborough (Herb. Massee), and Belle Croix, France (K. 1555), are both immature forms of the present species. M. Meylan has published a var. *gracile* (Bull. Soc. Bot. Genève, sér. 2. ii. 263 (1910)), with stalks two or three times the height of the sporangia.

Hab. On fir wood, *Sphagnum*, &c.—Somerset, Bedfordshire, Derbyshire, Yorkshire, Cumberland, North Wales, Scotland, West Ireland ; widely distributed throughout Europe and the United States ; recorded also from Japan.

2. **L. Carestianum** Rost. Mon., 188 (1875) (Abbé A. Carestia, who found the type in Piedmont, 1868). Plasmodium black. Sporangia forming short or elongate pulvinate plasmodiocarps, 1 to 15 mm. long, 0·5 to 1 mm. thick, brownish-grey, more or less clothed with white crystalline scales of lime ; sporangium-wall cartilaginous, brown. Columella convex or hardly evident, and represented by the thickened dark brown base of the sporangium-wall, spongy within and enclosing rounded nodules of lime. Capillitium of colourless or purple-brown branching and anastomosing threads 1 to 2 μ thick, often marked with dark bead-like warts. Spores dark purplish-grey,

minutely spinulose, 10 to 15 μ diam.—Mass. Mon., 255; Schinz Myxom. Schweiz, 63; Macbr. N. Am. Slime-Moulds, ed. 2, 145. *Reticularia Carestiana* Rabenh. Fung. Eur., no. 436 (1862). *Amaurochaete minor* Sacc. & Ellis in Mich., ii. 566 (1891).

Var. **granuliferum** Lister Mycetozoa, ed. 2, 140 (1911) (granule-bearing). Capillitium of branching and anastomosing purplish-brown threads, either with few expansions, each enclosing one or two rounded nodules of lime, 20 to 30 μ diam., or forming a dense network of nearly colourless threads expanded at the nodes to form star-shaped vesicles, each usually enclosing a nodule of lime; spores purple-brown, 12 to 18 μ diam.—Schinz l.c., 63 (1906). *Didymium granuliferum* Phill. in Grev., v. 114, t. 88, fig. 1 *a–f* (1877). *Badhamia granulifera* Mass. Mon., 321 (1892). *Lepidoderma granuliferum* R. E. Fr. in Arkiv. Bot., vi. no. 7, 3 (1906).

Pl. 115.—*a*. plasmodiocarp (Switzerland); *b*. sporangia of var. *granuliferum* (Blue Cañon, California); *c*. capillitium and spores of the same; *d*. spores with fragment of sporangium-wall showing a crystalline scale, and capillitium partly normal, partly with expansions enclosing lime-nodules (Switzerland).

This species appears on turf and twigs in alpine situations, often in great profusion, after the winter snows have melted. All stages occur between plasmodiocarps having normal capillitium free from lime, and those with capillitium branching to form the sponge-like network enclosing abundant lime-nodules characteristic of the var. *granuliferum*; the latter variety has now been obtained from California, Sweden, and Switzerland. Prof. Farlow found the typical form abundant also in the mountains of New Hampshire in the spring-time. Occasionally the capillitium threads are pale yellow and have a jointed outer sheath, a structure similar to that often seen in *Colloderma oculatum*.

Hab. On turf, dwarf willow, &c., in alpine regions.—Sweden, Dauphiné, Switzerland, North Italy, Moldavia, New Hampshire, California, and Utah.

3. **L. Chailletii** Rost. Mon., 189, fig. 179 (1875) (J. F. de Chaillet, 1747 to 1837, who found the species in Switzerland). Plasmodium dirty white. Sporangia loosely clustered or crowded, globose or hemispherical, 0·5 to 1 mm. diam., shortly stalked, sessile, or forming plasmodiocarps, grey or drab, with close-set crystalline scales of lime; sporangium-wall somewhat cartilaginous, pale purplish or yellow. Hypothallus orange or brown, sprinkled with calcareous scales, of spongy texture within, stalk brown, short, 0·1 to 0·2 mm. high. Columella pale or dark brown, rarely orange, clavate, hemispherical or scarcely evident; like the stalk it is of spongy texture within and contains numerous lime-nodules. Capillitium of slender purplish threads, branched and anastomosing. Spores purplish-grey, closely and minutely spinulose, paler on one side, 10 to 14 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 146. *L. Carestianum* var. *Chailletii* Lister Mycetozoa, ed. 2, 140 (1911).

Pl. 116.—*a*. sporangia (Arolla, Switzerland); *b*. sporangia (Devonshire); *c*. sporangia

with walls broken and showing columellae; *d.* capillitium and spores of same with fragment of sporangium-wall and crystalline scales; *e.* spore of same.

The type of *L. Chailletii* from Hauenstein, Bohemia, consists of clustered sessile sporangia, hemispherical on broad brown bases, with columellae ridge-like or hardly developed. This species is abundant in alpine regions in Switzerland. It has been found forming large colonies on dead leaves and earth in Devon, Somerset, and Bedfordshire, in the winter months; in these sporangia the upper part of the walls is often membranous and iridescent between the calcareous scales, and at length breaks up into small fragments adhering to the tips of the capillitium. M. Meylan has courteously sent us his var. *flavescens* of *L. Carestianum* (Bull. Soc. Vaud. Sc. Nat., xliv. 292 (1908)) from the Jura Mountains; it appears to be a form of the present species with orange-yellow inner sporangium-walls. He has also described a *f. roseum* of the same species (l.c. xlvi. 5 (1910)) in which the surface scales are rosy. This species is very closely allied on the one hand to *Didymium Wilczekii*, and on the other to *L. Carestianum*.

Hab. On dead leaves, twigs, &c.—Devon, Somerset, Bedfordshire; Dauphiné, Switzerland, Bohemia.

Genus 17.—**LEPTODERMA** G. Lister in Journ. Bot., li. 1, tab. 524, figs. 1, 1 *a–c* (1913) (λεπτός thin, δέρμα skin). Sporangia subglobose with membranous walls thickened towards the base with dark granular deposits amongst which small calcareous scales are often embedded. Capillitium a dense network of blackish threads. Spores purplish-grey.

1. **L. iridescens** G. Lister l.c. (ἶρις rainbow). Plasmodium grey or drab. Sporangia scattered or loosely clustered, sessile, rarely very shortly stalked, subglobose, greyish-purple, glossy, iridescent, 0·5 to 0·8 mm. diam.; sporangium-wall nearly hyaline above, purplish below, thickened and veined with brownish granular deposits and refuse-matter, often including scattered crystalline flakes of lime, 2 to 15 μ diam. Stalk short, stout, dark from enclosed refuse matter, spreading below into a dark hypothallus. Columella dark, convex, or none. Capillitium consisting of a persistent network of arching or flexuose dark purple threads, colourless at the extremities, radiating from the floor of the sporangium; the pale bases are often expanded and tubular, and may enclose granular matter. Spores purplish-grey, spinulose, 10 to 11 μ diam.—Schinz in Rab. Krypt. Fl., ed. 2, I. x. 227.

Pl. 131.—*h.* sporangia; *i.* capillitium.

Pl. 218.—*i.* sporangia, in two the capillitium is exposed; *k.* capillitium with fragment of sporangium-wall showing lime-crystals and refuse deposits; *l.* bases of capillitium threads and spores; *m.* spore.

This species closely resembles a limeless form of *Diachea*, but may be distinguished even when the lime-flakes are absent by the constant presence of dark granular deposits in the lower half of the sporangium-wall.

Hab. On dead leaves.—Bedfordshire, Somerset, Aberdeenshire, Elginshire, Germany, Switzerland, Moldavia.

Suborder II.—*AMAUROCHAETINEAE.*

Sporangia single, or combined into an aethalium, without deposits of lime; capillitium and spores dark brown or violet-brown, rarely ferruginous or colourless.

Family 1.—COLLODERMACEAE.

Sporangium-wall with an outer gelatinous layer.

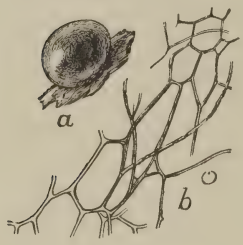


Fig. 26.—*Colloderma oculatum* G. Lister.
a. Moist sporangium, the dark mass of spores shows through the gelatinous envelope. Magnified 13 times.
b. Capillitium and spores. Magnified 140 times.

Fig. 26.

Genus 18.—**COLLODERMA.** G. Lister in Journ. Bot., xlviii. 312 (1910) (κόλλα glue, δέρμα skin). Sporangia usually sessile; sporangium-wall consisting of two layers; the outer gelatinous, with superficial deposits of granular refuse-matter; the inner layer membranous. Capillitium a network of purplish threads without lime-knots.

1. **C. oculatum** G. Lister, l.c. (furnished with an eye). Plasmodium purplish-brown. Sporangia scattered or grouped in small clusters, sessile, rarely stalked, either subglobose, 0·3 to 1 mm. diam., or forming straight or curved plasmodiocarps 1 to 3 mm. long, olive- or purplish-brown, glossy, sometimes seated on a brownish-purple hypothallus; sporangium-wall of two layers; the outer, when moist, thick, gelatinous, hyaline, more or less encrusted with yellowish-olive granular refuse-matter; the inner layer colourless, membranous, firm; if the sporangium on maturing slips out of the gelatinous envelope it appears shining iridescent blue or violet. Stalk, when present, short, stout, dark brown. Columella none. Capillitium consisting of branching and anastomosing pale or dark purplish-brown threads, colourless at the extremities, arising from the flat base of the sporangium, 2 to 4 μ diam. below, very slender towards the surface, often with a jointed appearance. Spores purplish-grey, distinctly spinulose, 11 to 15 μ diam.—Meylan in Ann. Cons. Bot. Genève, 1913, 313; Macbr. N. Am. Slime-Moulds, ed. 2, 147. *Didymium oculatum* Lippert in Verh. Zool.-Bot. Gesellsch. Wien, xliv. 72, t. 4 (1894).

Pl. 213.—*a*. mature sporangia; *b*. sporangium emerging from its moist gelatinous envelope.

This species was first observed by the late Christian Lippert, who described and figured it under the name of *Didymium oculatum*. It appeared on old fir wood that had been brought from near Hallstadt, Upper Austria, and kept for some months in a moist chamber. The presence of calcareous deposits in the sporangium-wall which Lippert described and which led him to name the species a *Didymium* has not been observed in numerous specimens obtained since from many localities. The young sporangia are at first dirty-white, then become yellow, and at length dark brown. When mature and dry the sporangium-walls are brittle and dehisce irregularly. If an unbroken sporangium be placed in water the outer gelatinous layer of the wall swells and forms a hyaline investment 0·1 to 0·2 mm. thick, completely surrounding the membranous inner layer with its enclosed mass of spores and capillitium, and the 'eye-like' effect is produced that suggested to Lippert the specific name of *oculatum*. Some of the capillitium threads in most gatherings show an unusual structure. They consist of a hyaline sheath enclosing a darker axis; this sheath may be interrupted to form long or short joints or segments. Other threads have the usual homogeneous character (see Tr. Br. Myc. Soc., iv. t. 1, figs. 1, *a–c*).

Hab. On dead wood, on mossy or lichened trunks of living trees, or on mossy peat; apparently not uncommon in the British Isles from summer to early spring. Recorded from Essex, Surrey, Devon, Somerset, Worcestershire, Salop, Derbyshire, Norfolk, Yorks, Isle of Man, Aberdeenshire, Switzerland, Austria, Portugal, New South Wales, Japan, New England.

Family II.—Stemonitaceae.

Sporangia stalked; sporangium-wall a delicate membrane, often evanescent; stalk solid, at least in the upper part, extending within the sporangium as a columella from which the branching threads of the capillitium take their origin. In this family the more or less solid stalk is developed within the young rising sporangium.

KEY TO THE GENERA OF *STEMONITACEAE*.

Sporangium-wall evanescent; capillitium springing from all parts of the elongated columella, ultimate branchlets united to form a surface net. (19) Stemonitis

Fig. 27.—*Stemonitis splendens* Rost.

a. Group of sporangia. Natural size.

b. Portion of capillitium and columella. Magnified 42 times.

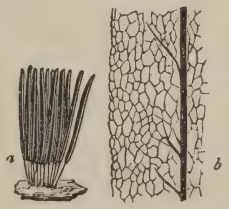


Fig. 27.

Sporangium-wall evanescent; capillitium as in *Stemonitis*,

but not forming a surface net, or only imperfectly towards the base of the sporangium. (20) COMATRICHA



Fig. 28.

Fig. 28.—*Comatricha nigra* Schroeter.

a. Group of sporangia. Natural size.

b. Sporangium deprived of spores showing the capillitium. Magnified 16 times.

Sporangium-wall evanescent ; columella reaching to the apex of the sporangium ; capillitium springing from beneath the superficially expanded end of the columella. (21) ENERTHENEMA



Fig. 29.

Fig. 29.—*Enerthenema papillatum* Rost.

a. Group of sporangia. Twice the natural size.

b. Sporangium. Magnified 16 times.

c. Sporangium deprived of spores, showing the capillitium. Magnified 16 times.

Sporangium-wall somewhat persistent as an iridescent membrane ; capillitium radiating from the columella. (22) LAMPRODERMA

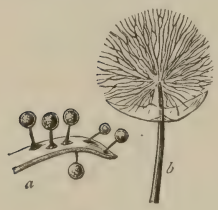


Fig. 30.

Fig. 30.—*Lamproderma scintillans* Morgan.

a. Group of sporangia. Magnified 2½ times.

b. Sporangium deprived of spores, showing capillitium. Magnified 25 times.

Sporangium-wall persistent in the form of minute discs at the tips of the rigid forking capillitium threads ; columella short or hardly evident. (23) CLASTODERMA



Fig. 31

Fig. 31.—*Clastoderma Debaryanum* Blytt.

a. Group of sporangia. Magnified 10 times.

b. Sporangia deprived of spores, showing capillitium. Magnified 64 times.

Capillitium scanty, colourless, branching from a short columella ; sporangia very minute. (24) ECHINOSTELIUM

Fig. 32.—*Echinostelium minutum* de Bary.

a. Group of three sporangia. Magnified 20 times.

b. Sporangium showing capillitium, all the spores dispersed but two. Magnified 280 times.

c. Spore. Magnified 500 times.

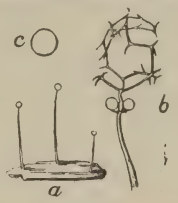


Fig. 32.

Sporangium-wall dark, dividing into persistent lobes ; capillitium dark, scanty. (25) BARBEYELLA

Fig. 33.—*Barbeyella minutissima* Meylan.

a. Sporangia on leaf of liverwort. Magnified 25 times.

b. Sporangium showing capillitium. Magnified 80 times.



Fig. 33.

Genus 19.—**STEMONITIS** Gleditsch Meth. Fung., 140, tab. iv (1753) (*στήμων*, thread). Sporangia cylindrical, stalked, fasciculate ; the solid black stalk extending within the sporangium to near the apex as a columella (except in confluent forms) ; capillitium formed of numerous threads radiating from all parts of the columella and combined into a loose network, the ultimate branches united into a surface net (this is often incomplete in irregular developments).

KEY TO THE SPECIES OF *STEMONITIS*.

A. Spores grey, violet-grey, or rufous-violet :—

a. Spores reticulated—

Sporangia usually in large clusters ; surface net of capillitium complete (except in vars. *flaccida* and *confluens*). 1. *S. fusca*

Sporangia in small clusters ; surface net of dense capillitium incomplete above ; spores with a complete lax reticulation formed of raised bands. 2. *S. virginiensis*

Like the last, but spores marked with scattered patches of close reticulation connected by faint lines. 3. *S. hyperopta*

B. Spores minutely warted, almost smooth—

Meshes of surface net rounded, 20 to 100 μ or more wide (imperfect in var. *flaccida*) ; spores 7 to 9 μ diam. 4. *S. splendens*

Similar to the last, but spores in clusters. 6. *S. uvifera*

Sporangia confluent, without definite surface net, spores 9 to 11 μ. 5. *S. confluens*

Meshes of smooth surface net angular, less than 20 μ wide ; spores 7 to 8 μ diam. ; plasmodium white ; sporangia clustered. 7. *S. herbatica*

Meshes of uneven surface less than 20 μ wide ; spores 7 to 8 μ diam. ; sporangia in small scattered groups or loosely clustered. 8. *S. pallida*

B. Spores pale ferruginous :—

Spores 7 to 9 μ diam. ; plasmodium yellow. 9. *S. flavogenita*

Spores 4 to 6 μ diam. ; plasmodium white. 10. *S. ferruginea*

1. **S. fusca** Roth in Roem. & Ust. Mag. Bot., I. ii. 26 (1787) (dark brown). Plasmodium white, in rotten wood, usually maturing at the place of emergence. Total height 5 to 20 mm. Sporangia cylindrical, obtuse, stalked, brownish-purple, usually in large clusters. Stalk black, shining, 1 to 4 mm. long, rising from a well-developed brown membranous hypothallus. Columella reaching to near the apex of the sporangium. Capillitium of dark brown threads springing from all parts of the columella, combined into a loose network, the ultimate branches forming a delicate smooth or spinose surface net, with angular, unequal meshes varying from 6 to 16 μ wide. Spores grey or rufous-violet, reticulated with rows of minute spines, 8 to 10 μ diam.—Rost. Mon., 193 ; Mass. Mon., 72, in part. *S. fasciculata* Pers. Obs. Myc., 56 (1796). *S. maxima* Schwein. in Trans. Amer. Phil. Soc., ser. 2, iv. 260 (1832) ; Macbr. N. Am. Slime-Moulds, ed. 2, 160. *S. dictyospora* Rost. l.c., 195 (1875) ; Mass. l.c., 83 ; Macbr. l.c., 161. *S. castillensis* Macbr. in Bull. Nat. Hist. Iowa, ii. 381 (1893). *Clathrus nudus* L. Sp. Pl., 1179 (1753) ? *Trichia nuda* Wither. Br. Pl., ed. 2, iii. 477 (1792) ? *Mucor araneosus* Jacq. Misc., ii. 376, t. 20 (1778) ?

Var. **rufescens** Lister Mycetozoa 110 (1894) (becoming reddish). Spores faintly reticulated with rows of minute spines, 5 to 8 μ diam.

Var. **trechispora** Torrend Fl. Myx., 141 (1909) (τρηχύς rough, σπορά seed). Spores reticulated with continuous raised bands. *Stemonitis trechispora* Macbr. l.c., 159.

Var. **nigrescens** Torr. l.c. (becoming black). Sporangia 3 to 4 mm. high ; capillitium usually lax with incomplete surface net ; spores 8 to 10 μ. *Stemonitis nigrescens* Rex in Proc. Acad. Nat. Sc. Phil. 1891, 392 ; Macbr. l.c., 162.

Var. **flaccida** Lister l.c., ed. 2, 144 (1911). Sporangia weak ; capillitium scarcely forming a surface net or surface net with very wide meshes connected by few slender threads to the columella.

Var. **confluens** Lister Mycetozoa, 110 (1894). Sporangia confluent, without surface net or columellae.—*Amaurochaete speciosa* Zukal in Verh. Zool.-Bot. Gesell. Wien, xxxv. 335, t. 15, fig. 8 (1885).

Pl. 118.—*a*, *b*. sporangia (England) ; *c*. capillitium ; *d*. sporangia, var. *rufescens* ; *e*. capillitium of var. *confluens* ; *f*. spore ; *g*. spores, var. *rufescens* ; *h*. spores from a sporangium showing characters of the typical form and var. *rufescens* ; *i*. spores with imperfect reticulation ; *k*, *l*, *m*. spores of var. *trechispora* from Venezuela, South Carolina, and Japan respectively.

Pl. 125.—*n*. form with scattered sporangia (Colorado) ; *o*. capillitium of same ; *p*. spore of same with broken reticulation.

This species is abundant in both temperate and tropical regions, and varies much in height, in density of capillitium, and in the markings and size of the spores. The five varieties described here serve as convenient centres round which to group some of the frequently recurring forms ; but gatherings representing connecting links are often met with. The vars. *flaccida* and *confluens* have weak or imperfectly developed capillitium, the result possibly of unfavourable conditions during development : var. *nigrescens* appears to be a stunted dwarf form with very dark, often lax capillitium and rather large dark spores : var. *trechispora* is an artificial centre which includes forms with spore-markings consisting of continuous bands, and may have either tall, short or confluent sporangia, with large or small spores which may be either strongly or faintly reticulated. An immersion objective is needed to see the delicate markings of the spores. Rostafinski's specimens of *S. fusca* from Vera Cruz (B.M. 631) and from Ruda Guzowska, Poland, have spores measuring 7 to 8 μ diam. ; they are not smooth, as he states, but show about 28 meshes of reticulation on the hemisphere. *S. dictyospora* Rost. appears to be an unnecessary name ; it is represented in Kew Herb. by two specimens referred to in Rost. Mon., App. 27. One of these from Ceylon (K. 1622), bearing the signature of Rostafinski, is *S. fusca* var. *rufescens* ; it has small spores, 5 to 6·5 μ diam., faintly reticulated with rows of spinules. The other specimen is from Venezuela, on a palm leaf (K. 1620, B.M. 648), and was marked by Berkeley *S. trechispora*, but this name was not published by him. It consists of small clusters of somewhat confluent sporangia with irregular columellae and imperfect surface net ; the spores are 10 to 12 μ diam., marked with a strong close reticulation in the form of raised bands giving an even border 1 μ broad. It is clearly an abnormal development, and is placed here under var. *trechispora*. Dr. Jahn describes an almost similar form appearing on a Sphagnum moor near Berlin, with the spore reticulation formed of continuous bands (Ber. Deutsch. Bot. Ges., xli. 394, figs. 1 *a* to *c* (1923)). The type of *S. maxima* Schwein. has spores 7 to 8 μ diam. with reticulation precisely like that of Rostafinski's *S. fusca* from Poland. The description and figure of *Amaurochaete speciosa* Zukal leave little doubt that this is the var. *confluens* of the present species. The confluent form of the sporangia may in some cases be seen throughout the whole development from one plasmodium, the capillitium consisting of a profuse network of arching threads with broad

expansions at the nodes; but sometimes only a part presents the confluent form, and is associated with more or less perfect sporangia with the normal surface net and columellae.

Hab. On dead wood: common in temperate and tropical regions: var. *trechispora* on wood, Sphagnum and other moss.

2. **S. virginiensis** Rex in Proc. Acad. Nat. Sc. Phil. 1891, 391 (State of Virginia, U.S.A.). Plasmodium ? Sporangia grouped in small clusters, shortly cylindrical, stalked, lilac-brown, total height 1·5 to 4 mm. Stalk 0·5 to 1 mm. long. Capillitium a dense network of flexuose dark brown threads, the ultimate branchlets slender, uniting to form a smooth or spinose close surface net, which is usually incomplete towards the summit of the sporangium. Spores pale lilac-brown, 5 to 8 μ diam., marked with a delicate and often lax reticulation of raised bands.—Macbr. N. Am. Slime-Moulds, ed. 2, 163. *Comatricha dictyospora* Cel. fil. Myx. Böhm., 49 (1893).

Pl. 125.—*q*. spores.

In the earlier editions of this book, this species was referred to under *Comatricha typhoides* var. *heterospora*, a well-marked and constant form which M. Meylan has raised to specific rank with the name *Stemonitis hyperopta*. From it the present nearly related species may be distinguished by the more complete surface net of the capillitium and by the spore markings.

Hab. On dead wood: recorded from Switzerland, Bohemia, Portugal, and Virginia, U.S.A.

3. **S. hyperopta** Meylan in Bull. Soc. Vaud. Sc. Nat., lii. 97 (1918) (ὑπέρ-οπτος proud or overlooked). Plasmodium watery-white. Sporangia in small loose clusters, shortly stalked, cylindrical, pinkish- or lilac-brown, total height 2 to 3·5 mm. Stalk 0·1 to 0·5 mm. high, continued into the slender columella. Capillitium a close network of flexuose brown threads springing from all parts of the columella, the ultimate branchlets slender and forming a more or less complete surface net in the lower half. Spores pale lilac, 5 to 6 μ diam., marked with small scattered patches of close-meshed reticulation, connected by very faint lines which form a lax net.—*Comatricha typhoides* var. *heterospora* Rex in Proc. Acad. Nat. Sc. Phil. 1893, 367; Lister Mycetozoa, ed. 2, 158; Macbr. N. Am. Slime-Moulds, ed. 2, 182.

Var. **microspora** Lister (μικρός small, σπορά spore). Sporangia loosely clustered or scattered; capillitium with a close uneven surface net formed of flexuose threads; spores 3·5 to 4 μ diam.—*Comatricha typhoides* var. *microspora* Lister Mycetozoa, 121 (1894). *C. microspora* G. Lister Guide to Brit. Mycet., ed. 4, 39 (1919).

Pl. 125.—*d*. sporangia; *e*. capillitium; *f*. spores; *g*. sporangia of var. *microspora*; *h*, *i*. capillitium and spores of same.

This constant and widely distributed form well merits specific rank. Like the preceding species it seems to lie on the border between the genera

Stemonitis and *Comatricha*; the capillitium differs from that of *C. typhoides* only in the presence of a delicate smooth surface net developed only in the lower half of the sporangium. The var. *microspora* is a constant form usually occurring on dead leaves, but sometimes on fir bark and dead wood; the dense capillitium has a well developed close surface net of very slender wavy threads; the minute spores show under an immersion objective markings similar to those of the typical form.

Hab. On dead coniferous wood: not uncommon in the British Isles; widely distributed in Europe and the United States; recorded also from Japan and South Chili: var. *microspora* on leaves and bark; recorded from Devon, Surrey, Essex, Norfolk, Germany, and Ohio.

4. **S. splendens** Rost. Mon., 195 (1875) (beautiful). Plasmodium creamy-white. Total height 6 to 20 mm. Sporangia cylindrical, obtuse, stalked, purplish-brown, closely fasciculate and forming large colonies. Stalk black, shining, slender, 1 to 4 mm. long, rising from a well-developed silvery or purplish hypothallus. Columella reaching to near the apex of the sporangium, rigid. Capillitium of purplish-brown threads, the principal branches springing at distant intervals from the columella, at first almost simple, suddenly branching to form a smooth surface net with rounded variously shaped meshes 20 to 70 μ wide. Spores pale reddish-purple, faintly and closely warted, 7 to 9 μ diam.—Torrend Fl. Myx., 141; Macbr. N. Am. Slime-Moulds, ed. 2, 164. *Stemonitis Morgani* Peck in Bot. Gaz., v. 33 (1880); Mass. Mon., 86; *S. maxima* Mass. (*non* Schwein.) l.c., 74 (1892). *S. Bauerlinii* Mass. l.c., 79. *S. acuminata* Mass. l.c., 78. *S. fenestrata* Macbr. l.c., 166.

Var. **Webberi** Lister Mycetozoa, 112 (1894) (H. J. Webber of Manhattan, Kansas). Sporangia stiff, erect; surface net complete, with meshes 80 to 100 μ wide.—*S. Webberi* Rex in Proc. Acad. Nat. Sci. Phil. 1891, 390; Macbr. l.c., 163.

Var. **flaccida** Lister l.c. Plasmodium white or pale yellow; sporangia weak, adhering to each other; capillitium lax, scarcely forming a surface net; membranous flakes of sporangium-wall always present; spores in mass chestnut-purple when fresh, soon fading to dark purple-brown.—*Comatricha flaccida* Morg. in Journ. Cinc. Soc. Nat. Hist., xvi. 135 (1894); Macbr. l.c., 174. *Stemonitis Tubulina* Alb. & Schw. Consp. Fung., 102 (1805)? *Dermodium fallax* Nees Syst., 109, fig. 103 (1816)? *Jundzilla Tubulina* Racib. in Hedw., xxvi. 111 (1887).

Pl. 121.—*a*, *b*, *c*. sporangia; *d*. capillitium of specimen from Texas quoted by Rostafinski; *e*. capillitium of var. *Webberi* (Cuba, B.M. 630); *f*. capillitium of *S. Morgani* Peck; *g*. sporangia of var. *flaccida*; *h*. capillitium of same, with a persistent flake of the sporangium-wall; *i*. spore.

The typical form of this species is represented by numerous specimens in the Strasburg, British Museum, and Kew collections, which were classed under *S. fusca* until Rostafinski detected the specific characters and gave the name of *S. splendens*. The capillitium in this species exhibits a wide

range of variation, but the spores are remarkably constant in colour, size, and in the minute, evenly distributed warts. A specimen from Cuba (B.M. 630), named *S. splendens* by Rostafinski, has a wide mesh to the surface net, and comes under var. *Webberi*; another specimen, also named *S. splendens* by Rostafinski, from Texas (K. 1631), has a much closer surface net, the meshes averaging 20 μ. *S. Bauerlinii* Mass., from New Guinea (K. 726), has the threads forming the surface net flattened out and expanded in some parts; an extreme form of a similar variety was described by Dr. Rex as *S. Bauerlinii* var. *fenestrata* (Proc. Acad. Nat. Sc. Phil. 1890, 36); this has the surface net so much expanded that it has almost the appearance of a membrane perforated by numerous round holes; the slender columella is often eccentric towards the apex; Dr. Rex observed all stages between this curious form and normal capillitium in developments of sporangia which appeared later on the same log. The var. *flaccida* merges into var. *Webberi*; it has even laxer capillitium, and such weak stalks and columellae that the sporangia sink together into a heap, from the edges of which the shining stalks are seen radiating outwards to the strong membranous hypothallus. The type of *S. acuminata* Mass. from the Cape is the typical form of *S. splendens* with spores measuring 7 to 8 μ (not 13 to 14 μ as given in Mass. Mon., 78).

Hab. On dead wood, especially on that of firs: var. *flaccida* is common in Great Britain and has been recorded from most temperate regions: var. *Webberi* has been gathered in the south-west of England and of Ireland; it is widely distributed in temperate and tropical regions; the typical form is very abundant throughout the tropics and in warm temperate regions; it has been recorded from Co. Down.

5. **S. confluens** Cooke & Ellis in Grev., v. 51 (1876). Plasmodium white. Sporangia clustered, confluent, often forming colonies several inches across; stalks short, indistinct or absent; columellae branched and irregular; surface net incomplete. Spores brownish-purple, 8 to 11 μ diam., closely spinulose.—Mass. Mon., 77; Macbr. N. Am. Slime-Moulds, ed. 2, 158. *S. splendens* var. *confluens* Lister Mycetozoa, 112 (1894). *Reticularia nitens* Morgan in Journ. Cinc. Soc. Nat. Hist., xviii. 40, pl. ii, fig. 11 (1895) ?

Pl. 121.—*k*. spore (England).

Closely allied to *S. splendens*, of which it may possibly be a confluent form; the spores, however, are usually rather larger and darker.

Hab. On dead wood: recorded from Somerset, Worcestershire, Hampshire, Surrey, Essex, Bedfordshire, Nottinghamshire, Aberdeen, and Co. Kerry; from France, North Germany, New England, and North Carolina.

6. **S. uvifera** Macbr. N. Am. Slime-Moulds, ed. 2, 161, pl. xx, fig. 8, 8 *a* to *c* (1922) (*uva* grape, *fero* I bear). Plasmodium ? Sporangia clustered 7 to 9 mm. high, resembling those of *S. splendens* in habit and in capillitium; the latter has membranous expansions in the axils of many of the branches. Spores purplish-grey, 7 to 9 μ, grouped in clusters of four or more, and marked with a cap of minute spines on the side facing outwards in the cluster.

The type of this species, gathered on Mt. Rainier, Washington, in 1914, shows the characters above described. A specimen collected by Mr. Hugo

Bilgram, near Philadelphia, is similar in having the spores adhering loosely in clusters, but they measure 9 to 11 μ and are equally spinulose all over; the capillitium forms a lax and irregular network of stout rugged threads and has the appearance of being an abnormal development.

Hab. On dead wood.—Washington Territory and Pennsylvania.

7. **S. herbatica** Peck in Rep. N. York Mus., xxvi. 75 (1874) (living on grass). Plasmodium white, rarely pale yellow. Sporangia cylindrical, closely clustered, in scattered tufts, 5 to 9 mm. high, brown or reddish-brown. Stalks 0·8 to 2 mm. high, arising from a membranous hypothallus. Capillitium of dark brown threads, springing from the columella and forming a loose network, uniting at the surface into a net with usually angular meshes, 10 to 20 μ diam. Spores pale reddish-grey, minutely spinulose, 6 to 8 μ diam.—Mass. Mon., 87; Macbr. N. Am. Slime-Moulds, ed. 2, 171. *S. decipiens* T. F. L. Nees, in Act. Phys. Med. Acad. Carolo-Leop., xvi. 95 (1820) ? *S. axifera* Macbr. l.c., ed. 1, 120 (1899), in part.

Var. **confluens** Lister Mycetozoa, ed. 2, 148 (1911). Sporangia united to form a convolute aethalioid mass, with somewhat persistent sporangium-walls, without distinct stalks or columellae; capillitium an irregular network without surface net.

Pl. 120.—*a*. sporangia (Peck's type from New York); *b*. capillitium; *c*, *d*. spores; *e*. capillitium of Java specimen; *f*. sporangia (Rangoon); *g*. capillitium of same.

S. herbatica holds an intermediate position between *S. flavogenita* and *S. splendens*, having the denser capillitium and the frequent habit of fruiting on herbaceous stems of the former species, and the stouter surface net and purplish spores of the latter. Different gatherings show a tendency towards one or other of its allies; although not a sharply defined species it makes a useful centre under which to place forms possessing a distinct general character which were difficult to locate before Peck gave them a specific rank. Rostafinski united the present species with *S. fusca*, from which it is distinguished by the nearly smooth spores and the wandering habit of the plasmodium. A gathering of *S. herbatica* from Freiburg is marked in the Strasburg Herbarium by de Bary '*S. fusca* var. *minor leiosperma*', while a small form of *S. fusca* from the same locality is named by him *S. fusca* var. *minor trachispora*. The var. *confluens* is a widely distributed form with persistent sporangium-walls.

Hab. On dead wood, leaves, and herbaceous stalks: widely distributed in the British Isles and in temperate regions; throughout the tropics it is abundant: var. *confluens* has been recorded from Essex, Worcestershire, Ceylon, Java, and Connecticut.

8. **S. pallida** Wingate in Macbr. N. Am. Slime-Moulds, 123 (1899). Plasmodium ? Total height 5 to 6 μ. Sporangia scattered or clustered in small groups, cylindrical on short stalks, violet-brown; resembling *S. herbatica*, but differing in the scattered habit, the uneven pale surface net of the capillitium formed of flexuose threads, and the firmer walled spores, 5 to 7 μ diam., which assume a 'coffee-bean' shape when dry.—Wingate in Ellis & Everh. N. Am. Fungi, no. 3498

(1897) ; Macbr. l.c., ed. 2, 169. *S. tenerrima* Morg. in Journ. Cinc. Nat. Hist. Soc., xvi. 137 (1894). *S. carolinensis* Macbr. l.c., 170 (1922).

Pl. 120.—*h.* sporangia (Philadelphia) ; *i.* capillitium ; *k, l.* spores, two are contracted and show the ' coffee-bean ' shape.

The stouter forms of this species almost merge into *S. herbatica*, while intermediate links unite the more slender forms with *S. ferruginea* var. *violacea*.

Hab. On dead wood : recorded from Moldavia, Japan, New Caledonia, Jamaica, New England, and many of the more southern United States.

9. **S. flavogenita** Jahn in Abh. Bot. Ver. Brandenb., xlv. 165 (1904) (*flavus* yellow, *genitus* brought forth). Plasmodium translucent citron-yellow. Total height 5 to 7 mm. Sporangia cylindrical, obtuse, closely clustered in scattered groups, shortly stalked or nearly sessile, cinnamon-brown. Stalk black, 0·5 to 1·5 mm. high. Columella often ceasing below the summit of the sporangium. Capillitium of ferruginous or brown threads, springing from the columella, and forming a loose network with numerous broad membranous expansions ; meshes of the delicate spinose surface net angular, rather uneven, varying from 6 to 16 diam. Spores pale ferruginous, faintly warted, 7 to 9 μ diam.—Lister in Journ. Bot., xlii. 135 ; Torrend Fl. Myx., 144 ; Macbr. N. Am. Slime-Moulds, ed. 2, 169. *S. ferruginea* Fr. Syst. Myc., iii. 158 (1829), in part ; Rost. Mon., 196, in part ; Mass. Mon., 85, in part ; Lister Mycetozoa, 114.

Pl. 119.—*a.* sporangia (England) ; *b.* capillitium ; *c.* capillitium and columella, the latter expanded to form a membranous cap at the apex of the sporangium ; *d.* spore.

This species is abundant in the British Isles, and appears to be not uncommon in Europe ; it has been recorded elsewhere from Oregon only. It is allied on the one hand to *S. herbatica*, and on the other to *S. ferruginea*, under which species it was included by the earlier authors ; from the former it is distinguished by the delicate spinose surface net of the capillitium and ferruginous spores, and from the latter by the shortly stalked sporangia and larger spores measuring 7 to 9 μ ; from both it differs in the yellow colour of the plasmodium. In the first edition of the present work this species is described under the name of *S. ferruginea* Ehrenb. ; Dr. Jahn's researches have shown that the type of the latter, preserved in the Berlin Museum, is the following small-spored species, which was described as *S. Smithii* Macbr. in Mycetozoa, 115. Neither Fries nor Rostafinski distinguished the present species from *S. ferruginea*, the plasmodium of which they describe as yellow.

Hab. On dead wood, leaves and herbage : frequent in the British Isles in summer and autumn ; recorded from Sweden, France, Germany, Switzerland, Hungary, Bohemia, and Roumania ; also from Oregon (*teste* Prof. Macbride).

10. **S. ferruginea** Ehrenb. Sylv. Myc. Berol., 25 (1818) (rusty). Plasmodium white. Total height 7 to 20 mm. Sporangia cylindrical, in dense and often large clusters, stalked, cinnamon-brown. Stalks black, 3 to 7 mm. long,

arising from a membranous hypothallus. Columella ceasing below the apex of the sporangium. Capillitium with a smooth and usually close surface net, connected with the columella by (usually) few stout branches, and composed of rather firm threads bounding rounded meshes; the latter vary much in size in different developments. Spores pale ferruginous, nearly smooth, 4 to 6 μ diam.—Rost. Mon., 196, in part; Mass. Mon., 85, in part; Jahn in Abh. Bot. Ver. Brandenb., xlv. 164. *Trichia axifera* Bull. Champ., 118, t. 477, fig. 1 (1791)? *S. fasciculata* Schum. Enum. Pl. Saell., ii. 216 (1803)? *S. violacea* Schum. l.c.? *S. Smithii* Lister Mycetozoa, 115. *S. microspora* Lister in litt. ex Morgan in Journ. Cinc. Soc. Nat. Hist., xvi. 138 (1894). *S. axifera* Macbr. N. Am. Slime-Moulds, ed. 2, 168.

Var. **Smithii** Lister Mycetozoa, ed. 2, 150 (1911) (C. L. Smith). Sporangia 3 to 6 mm. high, with surface net of very slender threads, often uneven, the inner capillitium well developed.—*S. Smithii* Macbr. in Bull. Nat. Hist., ii. 381 (1893), and N. Am. Slime-Moulds, ed. 2, 167. *S. subclavata* Zoll. in Flora, xxx. 301 (1847)?

Var. **violacea** Meyl. in Bull. Soc. Bot. Genève, sér. 2, ii. 264 (1910). Sporangia slender, 5 mm. high; capillitium with rather uneven surface net; spores with a violet shade, 4 to 6 μ.

Pl. 119.—*e.* sporangia of various sizes (England); *f.* capillitium; *g.* spore.

This handsome species is subject to much variation in the size of the sporangia and the stoutness of the capillitium. The type of var. *Smithii* found by C. L. Smith in Nicaragua, 1893, has minute sporangia with capillitium showing abundant intermediate network and a very slender surface net; the same form has now been found in many places, and is connected with typical *S. ferruginea* by numerous gatherings showing intermediate characters: it bears considerable resemblance to *Comatricha typhoides* var. *microspora* from which it is distinguished by the more even and perfect surface net and the smoother spores. Prof. Macbride considers, and perhaps rightly, that Bulliard's description and illustration of *Trichia axifera* refer to the present species; but Bulliard describes no other species of what we know now as *Stemonitis*, and quotes under *T. axifera* synonymy that might apply to any member of the genus. It seems on the whole better not to discard the well-established name *ferruginea* given by Ehrenberg as to the application of which there is no uncertainty.

Hab. On dead wood: the typical form is widely distributed and abundant in temperate and tropical regions: var. *Smithii* has been recorded from Yorkshire, Aberdeen, Switzerland, Ceylon, Java, Ottawa, New York, Pennsylvania, Nicaragua, Antigua, and S. Chili: var. *violacea* has been recorded from Worcestershire and the Jura Mountains.

Genus 20.—**COMATRICHA** Preuss in Linnaea, xxiv. 140 (1851) (κόμη head of hair, θρίξ wool). Sporangia cylindrical, ovoid or globose, gregarious or scattered; sporangium-wall evanescent (subpersistent in *C. typhoides*); stalk extending within the sporangium as a columella; capillitium consisting of numerous threads usually combined into a more or less uniform network, not uniting to form an even surface net.

The genus *Comatricha* is an artificial one: it includes species which agree with *Lamproderma* in all characters but the persistent sporangium-wall; from *Stemonitis* it differs only in the less clustered habit of the sporangia (except in *C. longa*), and in the absence of a smooth surface net to the capillitium.

KEY TO THE SPECIES OF *COMATRICHA*.

A. Spores rather dark brownish-violet or grey (by transmitted light) :—

A. Spores nearly smooth—

Capillitium dense, crisped or flexuose, usually arising from the whole length of the columella; spores brown in mass, 7 to 10 μ diam. 1. *C. nigra*

Resembling *C. nigra*, but spores black in mass, 10 to 11 μ diam. 2. *C. Suksdorfii*

Capillitium with primary branches stout and nearly straight, arising from the whole length of the columella. 3. *C. laxa*

Capillitium dense, arising by a few branches only from the apex of the columella. 4. *C. elegans*

Capillitium a tuft of nearly simple threads with clavate tips. 5. *C. fimbriata*

Capillitium of few rigid branching scarcely anastomosing threads; stalk translucent yellow-brown below. 6. *C. cornea*

B. Spores distinctly spinulose or reticulated—

a. Sporangia globose; columella ending in strong branches continued into the flexuose network of the capillitium; spores warted. 7. *C. lurida*

b. Sporangia long, slender, cylindrical—

Spores closely reticulated. 12. *C. longa*

Spores spinulose. 13. *C. irregularis*

B. Spores pale; lilac or reddish-lilac :—

A. Spores 5 to 6 μ, marked with a few widely scattered warts or clusters of minute warts, otherwise smooth. 8. *C. typhoides*

B. Spores minutely spinulose all over, 6 to 8 μ diam.—

Sporangium-wall completely evanescent; capillitium brown; on leaves (on wood in var. *gracilis*). 9. *C. pulchella*

Similar to the last, but stalks usually longer, capillitium flesh-coloured; on herbaceous stalks. 10. *C. tenerrima*

Sporangium-wall persistent at the base as a membranous cup attached to the capillitium; on leaves. 11. *C. rubens*

1. **C. nigra** Schroeter in Cohn Krypt. Fl. Schles., iii. 1. 118 (1885) (black). Plasmodium watery-white. Total height 1 to 6 mm. Sporangia globose, ellipsoid or cylindrical, stalked, scattered or gregarious, about 0·6 mm. diam., purplish-brown; sporangium-wall evanescent. Stalk subulate, slender, black, shining; in the globose form usually 2 to 6 times the length of the sporangium, equalling the length of the sporangium or shorter in the cylindrical form, rising from a more or less distinct hypothallus. Columella reaching to half the height, or nearly to the apex of the sporangium, branching above and continued into the capillitium. Capillitium a more or less dense tangle of purplish-brown threads, springing from all parts of the columella, anastomosing and branching in arching curves, of nearly equal thickness throughout, the ultimate branches looped and showing few free ends or marked with short spine-like branchlets. Spores brownish-violet, minutely and closely spinulose, 5·5 to 11 μ, average 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 178; Sturgis in Colorado Coll. Publ., Sci. Ser., xii. 33. *Stemonitis nigra* Pers. in Gmel. Syst. Nat., 1467 (1791). *S. atrofusca* Pers. in Roemer N. Mag. Bot., 91 (1794). *S. reticulata* Trentep. in Roth Catal. Bot., i. 223 (1797) ? *S. ovata* Pers. Syn. Fung., 189 (1801). *S. globosa* Schum. Enum. Pl. Saell., ii. 217 (1803) ? *S. obtusata* Fr. Syst. Myc., iii. 160 (1829). *S. oblonga* Fr. l.c., 159. *S. Friesiana* de Bary in Rabenh. Fung. Eur., no. 568 (1863); Mass. Mon., 82. *Trichia alba* Sow. Engl. Fung., t. 259 (1803) (*nomen*). *T. mucoriformis* Schum. l.c., 211. *Comatricha obtusata* Preuss in Linnaea, xxiv. 141 (1851); Lister Mycetozoa, 117. *C. Friesiana* Rost. Mon., 199 (1875). *C. Persoonii* var. *gracilis* Čel. fil. Myx. Böhm., 50, t. 2, f. 4, 5 (1893).

Var. **alta** Lister Mycetozoa, ed. 2, 152 (1911) (tall). Sporangia oblong or cylindrical; capillitium a tangle of long flexuose threads attached chiefly by a few branches to the base of the columella.—*C. alta* Preuss l.c., 141, and in Sturm Deutschl. Fl., Pilze, xxxvi. 141, t. 71 (1862). *C. filamentosa* Meyl. in Bull. Soc. Vaud. Sc. Nat., liii. 456 (1921).

Var. **aequalis** Sturgis l.c., 34 (equal). Plasmodium milk-white. Sporangia scattered, slender, cylindrical, 2 to 4 mm. long, on slender stalks 2 to 2·5 mm. high; capillitium a dense network of violet-brown threads.—*C. aequalis* Peck in Rep. N. York Mus., xxxi. 42 (1879); Brandza in Ann. Sc. de l'Univ. de Jassy, xi. 127 (1921); Macbr. N. Am. Slime-Moulds, ed. 2, 180. *Stemonitis aequalis* Mass. Mon., 80 (1892).

Var. **subcaespitosa** Lister (somewhat clustered). Sporangia ellipsoid on short stalks ; 2 mm. in total height ; capillitium with more or less of a surface net of slender threads ; spores 8 to 9 μ.—*Comatricha subcaespitosa* Peck in Rep. N. York Mus., xliii. 25 (1890) ; Macbr. l.c., 185. *C. Persoonii* var. *subcaespitosa* Torr. Fl. Myx., 137 (1909). *Stemonitis subcaespitosa* Mass. Mon., 80 (1892).

Pl. 123.—*a*, *b*. round sporangia (England) ; *c*. capillitium of same ; *d*. cylindrical sporangia with capillitium of same ; *d*. cylindrical sporangia of var. *alta* ; *e*, *f*. capillitium and spore of same ; *g*. base of a small sporangium (fig. *b*) showing capillitium with surface net ; *h*. cylindrical sporangia (England) ; *l*. sporangia of var. *aequalis* (New Hampshire) ; *m*, *n*. capillitium and spore of same.

A very abundant and variable species ; in a development of the usual form, minute sporangia may occur showing a close even surface net in the lower part of the capillitium, or they may approach *C. laxa* in having few and rigid primary capillitium branches (cf. *C. Persoonii* Čel. fil., l.c.). In the var. *alta* the tangle of capillitium at length falls away from the upper part of the columella, leaving the naked spike-like apex exposed. *C. filamentosa* Meylan is a small form of this variety, 1 to 1·5 mm. in total height. The var. *aequalis* is a tall slender and constant form connected with typical *C. nigra* by many intermediate gatherings. The var. *subcaespitosa* is an elegant little form with almost *Stemonitis*-like capillitium ; it has been recorded apparently from New England only, although specimens somewhat resembling it, but without such a smooth surface net have been found in England and in the Jura Mountains. M. Meylan has published a var. *microspora* (Ann. Cons. Bot. Genève, 1913, 316), a long-stalked form with ellipsoid sporangia and spores measuring 6 to 8 μ, which he has obtained repeatedly in the Jura Mountains.

Hab. On dead wood : the typical form is common and widely distributed in temperate regions of both hemispheres ; recorded also from Ceylon and Java ; var. *alta* is not uncommon in England and Scotland, and has been recorded from Ireland, Germany, Switzerland, the Cape, and New Zealand : var. *aequalis* from Aberdeenshire, Moldavia, New York, Pennsylvania, Ohio, Illinois, Oregon, Colorado, New Mexico.

2. **C. Suksdorfii** Macbr. N. Am. Slime-Moulds, 132 (1899) (W. N. Suksdorf). Plasmodium ? Sporangia scattered, globose or cylindrical, 0·5 to 0·9 mm. diam., purple-black. Stalk cylindrical, 0·3 to 0·7 mm. high. Capillitium a dense network of flexuose black threads springing from all parts of the columella. Spores 9 to 13 μ, purplish-grey, faintly spinulose.—Macbr. l.c., ed. 2, 178. *Stemonitis Suksdorfii* Ellis & Everh. in Bull. Washburn Coll., i. 5 (1884) ; Mass. Mon., 76. *Comatricha obtusata* Lister Mycetozoa, 118 (1894), in part. *C. nigra* var. *Suksdorfii* Sturgis in Colorado Coll. Publ., Sci. Ser., xii. 33 (1907).

Pl. 123.—*i*. capillitium (Colorado) ; *k*. spore.

This robust species is closely allied to *C. nigra*, with which it is connected by intermediate forms ; the distinguishing characters are, however, retained in repeated gatherings from the Western States of America and from Switzerland. It is named after W. N. Suksdorf who collected it in the autumn of 1883 in Washington Territory. M. Meylan describes a var. *aggregata* (Bull. Soc. Vaud. Sc. Nat., liii. 455 (1921)) with clustered, almost confluent sporangia, and with very lax capillitium.

Hab. On dead coniferous wood in subalpine regions.—Switzerland, Colorado, Oregon, and Washington.

3. **C. laxa** Rost. Mon., 201 (1875) (loose). Plasmodium watery-white. Total height, 1 to 3·5 mm. Sporangia subglobose or shortly cylindrical, obtuse, scattered or gregarious. Stalk black, shining, often stout, 0·2 to 0·6 mm. long. Columella reaching nearly to the apex of the sporangium, narrowed upwards. Capillitium usually lax, the primary threads springing from all parts of the columella, at first straight or slightly curved, branching towards the surface to form a loose network of slender threads, either looped and anastomosing or with numerous straight free ends. Spores purplish-grey or brown, minutely and closely spinulose, 7 to 13 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 177. *Stemonitis laxa* Mass. Mon., 79 (1892). *Badhamia penetralis* Cooke & Ellis in Grev., v. 49 (1876) ? *Lamproderma Ellisiana* Cooke in Ann. Lyc. Nat. Hist. N. York, xi. 397 (1877) ? *Comatricha macrosperma* Racib. in Rozpr. Mat. Przyr. Akad. Krak., xii. 76 (1884). *C. Ellisiana* Ellis & Everh. N. Am. Fung., ser. 2, no. 2696 (1891). *C. Sommerfeltii* Blytt in Bidr. K. Norg., Sop. iii. 8 (1892). *C. Ellisii* Morg. in Journ. Cinc. Soc. Nat. Hist., xvi. 133 (1894); Macbr. l.c., 184.

Var. **rigida** Brandza in Ann. Sc. de l'Univ. de Jassy, xi. 126 (1921). Capillitium scanty, of rather rigid threads; columella often widely forking at the apex; spores 8 to 13 μ, spinulose.

Pl. 124.—*a*, *b*, *c*. sporangia of various shapes (England); *d*. three sporangia showing capillitium; *e*. capillitium; *f*, *g*. spores.

Intermediate forms connect this species with *C. nigra*, of which it is hardly more than a marked variety. The type in the Strasburg collection is well rendered by the photographic figure in Rostafinski's Monograph; it is a globose form with coarse and lax capillitium. A similar form is found at Lyme Regis accompanied by more elongated sporangia with denser capillitium resembling the type of *C. Ellisiana* Ellis & Everh. (B.M. 1800). *C. Sommerfeltii* Blytt has the lax capillitium of Rostafinski's type of *C. laxa*, but has larger spores, 11 to 14 μ diam.; *C. macrosperma* Racib. and *C. laxa* var. *microcarpa* Meylan (Bull. Soc. Vaud. Sc. Nat., liii. 456 (1921)) both represent a large-spored form, which is not of unfrequent occurrence; the large spores are often but not always associated with scanty capillitium. *Lamproderma Ellisiana* Cooke is described as having spherical sporangia on subulate stalks, slender forking, blackish-purple capillitium threads radiating from the apex of a short columella, and pale lilac spores, 15 to 16 μ diam., grouped in small clusters. Nothing remains of the type from New Jersey (K. 614) but a few naked stalks; whether the specimen was in part a *Lamproderma*, as Massee believed (Mon., 98), or a form of *Comatricha laxa*, the same form in fact as *Comatricha Ellisiana* (syn. *Lamproderma Ellisiana* Ellis & Everh.), cannot now be determined.

Hab. On dead wood and twigs: not uncommon in the British Isles, and widely distributed throughout Europe and the United States; recorded also from Malaya and Japan; var. *rigida* from Roumania and Minnesota.

4. **C. elegans** Lister in Guide to British Mycetozoa, ed. 3, 31

(1909). Plasmodium watery-white. Sporangia usually scattered, globose, 0·2 to 0·5 mm. diam., purplish-brown. Stalks black, slender, subulate, 0·6 to 1 mm. high. Columella short, soon dividing into the few straight primary branches of the capillitium ; these again branch repeatedly and form towards the surface of the sporangium a loose tangle of slender flexuose anastomosing threads ; spores pale brownish-violet, very faintly spinulose, 8 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 182. *Rostafinskia elegans* Racib. in Rozpr. Mat. Przyr. Akad. Krak., xii. 77 (1884) ; Torrend Fl. Myx., 132. *Raciborskia elegans* Berl. in Sacc. Syll., vii. 400 (1888) ; Mass. Mon., 108 ; Lister Mycetozoa, 133. *Orthotrichia Raciborskii* Čel. fil. Myx. Böhm., 54 (1893) ?

Var. **pallens** G. Lister (pale). Spores pale reddish-lilac in mass.

Pl. 124.—*h.* sporangia (Ceylon) ; *i, k.* sporangia after dispersion of spores ; *l.* capillitium threads ; *m, n.* spores.

Although closely allied to *C. nigra* and connected with it by intermediate gatherings, this form has now been obtained from many parts of the world retaining the characteristic branching of the capillitium. *C. elegans* shows considerable resemblance to *Lamproderma arcyrionema*, but differs in the completely evanescent sporangium-wall and in the larger spores. The description of *Orthotrichia Raciborskii* well describes the present species, but the mounted specimen courteously shown us by Dr. Čelakovsky is a minute form of *C. nigra*. The var. *pallens* was found by Mrs. Stelfox in Co. Down, in August, 1915 ; it is comparable to a pale lilac-spored form of *Enerthenema papillatum* found by M. C. Meylan in the Jura Mountains.

Hab. On dead wood : widely distributed in the British Isles and Europe ; recorded also from Japan, New Brunswick, Quebec, South Carolina, and Colorado.

5. **C. fimbriata** G. Lister & Cran in Journ. Bot., lv. 122, pl. 548, figs. 2, 2 *a–d* (1917) (fringed). Plasmodium colourless. Sporangia scattered, stalked, globose, blackish-brown, 0·1 to 0·35 mm. diam. Stalk black, subulate, slender, straight or curved, 0·5 to 1 mm. high. Capillitium arising chiefly from the summit of a short truncate columella, consisting of a scanty tuft of purplish-brown threads, extremely slender at the base, either simple throughout or forking below the clavate or irregularly expanded tips. Spores 10 to 12 μ diam., greyish-purple, paler and smoother on one side, closely and minutely spinulose.

Pl. 214.—*e.* group of sporangia, from four of which the spores have fallen ; *f.* sporangium after spore dispersion ; *g.* base of stalk, showing reticulate structure ; *h, i.* spores.

This minute species appears to be not uncommon in Britain. It may be easily overlooked as the ripe spores fall away at a breath, leaving the slender stalks with their tuft of scanty capillitium as shadowy objects. The lower part of the stalk, when mounted, is seen to consist of a sheath of purplish-brown anastomosing strands with slender connecting bars, enclosing a loose network of paler strands ; a similar structure may sometimes be seen in minute specimens of other species of *Comatricha*.

Hab. On dead coniferous wood, bramble-stems, &c.—Essex, Hirt Hill and Weybridge, Surrey, Buckinghamshire, Norfolk, Worcestershire, Cheshire, and Aberdeenshire.

6. **C. cornea** G. Lister & Cran in Journ. Bot., lv. 121, pl. 548, figs. 1, 1 *a–e* (1917) (horny). Plasmodium colourless. Sporangia scattered or solitary, stalked, globose, dark brown, 0·12 to 0·32 diam. Stalk subulate, slender, straight, 0·17 to 0·2 mm. high, dark brown above, brownish-yellow below where it expands into a discoid hypothallus. Columella brown, cylindrical, reaching one-third to one-half the height of the sporangium, with a small collar where it meets the stalk, dividing above into the two or three primary branches of the capillitium; these fork repeatedly and end at the surface in short rigid diverging branchlets. Spores 8·5 to 9 μ, grey, minutely warted, the spore-wall thinner on one side.

Pl. 214.—*a.* sporangia on a moss leaf, the spores dispersed; *b.* sporangium showing capillitium; *c.* expanded base of stalk; *d.* branchlets of capillitium; *e.* spore.

A very small species, found by the Rev. W. Cran almost every year in summer and autumn since 1913 near Aberdeen. The structure of the stalk is unusual; it consists of a smooth thick-walled tube enclosing a central strand of parallel pale brown fibres.

Hab. On moss and bark.—Aberdeenshire, Chorin (Germany, Dr. Jahn), Jura Mountains (C. Meylan).

7. **C. lurida** Lister Mycetozoa, 119 (1894). Plasmodium watery-white. Total height 1·25 mm. Sporangia scattered, globose or shortly ovoid, erect, 0·5 mm. diam., stalked, purplish-brown; sporangium-wall evanescent. Stalk setaceous, black, shining, 0·75 mm. long, rising from a circular brown hypothallus. Columella cylindrical, reaching to half the height of the sporangium, dividing into stout branches at the apex, and continued into the capillitium. Capillitium dark purplish-brown throughout, spreading from the upper part of the columella in flexuose anastomosing threads, with slender brown free ends. Spores spherical or subovoid, purplish-grey, coarsely warted, 6 to 10 μ diam.—Torrend Fl. Myx., 135.

Pl. 127.—*a.* sporangia (England); *b.* columella and capillitium with a fragment of sporangium-wall to which spores are adhering; *c.* spore.

This species has the habit of *Lamproderma scintillans*, from which it is distinguished by the evanescent sporangium-wall, the more branching columella, the uniform colour of the flexuose capillitium, and also by the more closely warted spores.

Hab. On decaying leaves, especially those of holly and ivy, rarely on wood: abundant in some years from autumn to spring in South Devon and in Surrey; recorded also from Somerset, Worcestershire, Bedfordshire, Norfolk, North Wales, Nairnshire, Aberdeen, and Moldavia; reported also from the island of Saghalien (K. Minakata).

8. **C. typhoides** Rost. Versuch, 7 (1873) (*Typha* reed-mace). Plasmodium watery-white. Total height 2 to 3 mm. Spor-

angia in loose clusters or scattered, stalked, cylindrical, obtuse, at first silvery-grey from the presence of the soon evanescent wall, then lilac-brown, 1·5 to 2·3 mm. long, 0·5 mm. broad. Stalk black, clothed with the silvery membranous continuation of the sporangium-wall, 0·5 to 1·3 mm. long, 0·06 mm. thick, rising from a well-developed hypothallus. Columella reaching nearly to the summit of the sporangium, branching at the apex. Capillitium a close network of flexuose, pale brown threads, springing from all parts of the columella, the ultimate branchlets, more slender, free or uniting to form an imperfect surface net in the lower half. Spores pale lilac-brown, marked with 3 to 5 prominent warts or clusters of minute warts on the hemisphere, otherwise smooth or very minutely warted, 6 to 7 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 181. *Trichia typhoides* Bull. Champ., 119, t. 477, fig. 2 (1791). *Stemonitis typhina* Wiggers Prim. Fl. Hols., 110 (1780) ? * ; Pers. Obs. Myc., i. 57 ; Mass. Mon., 74. *Stemonitis typhoides* DC. Fl. Fr., ii. 257 (1805). *S. pumila* Corda Icones, v. 59 (1842). *S. affinis* Mass. l.c., 76 (1892). *S. atra* Mass. l.c., 78. *S. Carlylei* Mass. l.c., 84. *S. platensis* Speg. in Anal. Mus. Nac. Buenos Aires, vi. 202 (1899). *Comatricha typhina* Rost. Mon., 197 (1875). *C. affinis* Rost. l.c., 202. *C. Stemonitis* Wettst. in Verh. Zool.-Bot. Gesellsch., xxxv. 534 (1885) ; Macbr. l.c., ed. 1, 130 (1899).

Var. **similis** Lister Mycetozoa, ed. 2, 158 (1911) (like). Sporangia slender, cylindrical ; sporangium-walls evanescent ; stalk without a silvery sheath ; capillitium with an uneven surface net below ; spores 6 to 7 μ diam., faintly warted with a few larger and many smaller warts.

Pl. 125.—*a*. sporangia (England) ; *b*. capillitium ; *c*. spores.

This abundant and widely distributed species shows some variety in the denseness of its capillitium and the amount to which the surface net is developed ; the scattered warts on the spores are, however, always present. The young watery-white sporangia usually emerge from the wood separately, but sometimes a cluster of sporangia is differentiated from a cushion-like mass of plasmodium, as in most species of *Stemonitis*. The type of *C. affinis*, Rost. from Freiburg (Strasb. Herb.) is not well developed, but the capillitium is that of the present species, and the spores have the characteristic scattered warts. *Stemonitis atra* Mass., from New Zealand (K. 727), has spores 6 to 8 μ diam., and appears to be the usual form of *C. typhoides*. The var. *similis* has hitherto been found only in the United States ; the sporangia somewhat resemble those of *C. pulchella* var. *gracilis*, but differ in being much longer and in having spores marked with warts of unequal size.

Hab. On decayed wood : abundant in summer and autumn in the British Isles, throughout Europe, the United States, and in temperate regions generally ; apparently not uncommon in the tropics.

* The early names quoted by Rostafinski as synonyms for this species, such as *Mucor Stemonitis* Scop., *Clathrus pertusus* Batsch, *Stemonitis typhina* Wiggers, are accompanied by vague and imperfect descriptions. Bulliard's excellent figures of *Trichia typhoides* leave no doubt as to the species he represents.

9. **C. pulchella** Rost. Mon., App. 27 (1876) (pretty). Plasmodium watery-white. Total height 0·7 to 1·5 mm. Sporangia scattered, ovoid or cylindrical, stalked, lilac- or rufous-brown; sporangium-wall evanescent. Stalk black, 0·2 to 0·5 mm. high, rising from a circular, membranous hypothallus. Columella reaching nearly to the apex of the sporangium. Capillitium a network of flexuose anastomosing brown threads springing from all parts of the columella, looped at the surface, with few free ends. Spores pale lilac-brown, minutely but distinctly warted, 6 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 183. *Stemonitis pulchella* Church. Bab. in Proc. Linn. Soc., i. 32 (1839) (*nomen*); Berk. in Ann. Mag. Nat. Hist., ser. 1, vi. 431, t. 12, fig. 11; Mass. Mon., 86. *Comatricha Persoonii* Rost. Mon., 201 (1875); Lister Mycetozoa, 122.

Var. **fusca** Lister in Journ. Bot., xxxv. 215 (1879) (dark brown). Sporangia as in the type, but with more rigid purplish-brown capillitium, and pale greyish-brown spores.

Var. **gracilis** Lister Mycetozoa, ed. 2, 156 (1911). Sporangia narrowly cylindrical; stalks 0·2 to 0·5 mm. high; capillitium threads usually uniting to form a close uneven surface net; spores pale violet-grey, very faintly warted, 5·6 to 7 μ.—*C. gracilis* Wingate in Ellis & Everh. N. Am. Fung., ser. 2, no. 2094 (1888). *C. Persoonii* Macbr. l.c., ed. 1, 132 (1899), in part.

Pl. 126.—*a*. sporangia (England); *b*. capillitium and spores; *c*. spore; *d*. capillitium and spores of var. *fusca*; *e*. spore; *i*. sporangia of var. *gracilis* (Japan); *k*, *l*. capillitium and spores of same.

This species differs from *C. nigra* and *C. laxa* in the paler capillitium, and in the paler and more distinctly warted spores. The typical form is common in the British Isles and in Europe, but appears to be rare elsewhere; the var. *gracilis* is the usual representative of the species in the tropics and Japan, where it often forms large colonies of close-ranked sporangia.

Hab. On dead leaves, in autumn: abundant in the British Isles, and widely distributed in North Temperate regions; recorded also from N. India and Malaya: var. *fusca* on leaves; recorded from Essex, Surrey, Somerset, Worcestershire, North Wales, Aberdeenshire, and Switzerland: var. *gracilis* on wood and herbaceous stalks; North Germany, Austria, Moldavia, South Nigeria, Cameroons, Ceylon, Japan, Pennsylvania.

10. **C. tenerrima** G. Lister in Guide to British Mycetozoa, ed. 4, 39 (1919) (most delicate). Plasmodium watery-white. Sporangia scattered, stalked, ovoid or narrowly cylindrical, acute or obtuse, pale red, brownish-pink or lilac-pink, equalling or shorter than the slender black stalks; total height 1·5 to 2 mm. Columella slender, often reaching to the summit of the sporangium. Capillitium a network of slender flexuose pale red threads. Spores pale flesh-coloured, minutely warted, 7 to 8 μ diam.—*C. pulchella* var. *tenerrima* Lister Mycetozoa, ed. 2, 156 (1911). *Stemonitis tenerrima* Curtis in Sill. Am. Journ., vi. 352 (1848); Berk. & Curt. in Grev., ii. 69.

Pl. 126.—*f.* sporangia; *g*, *h*. capillitium and spores.

This slender little species appears to be constant in the pale colour of the capillitium and spores; the stalks are usually longer than in *C. pulchella*, to which it is nearly allied.

Hab. On dead herbaceous stalks and dead wood: not uncommon in Great Britain from summer to winter; recorded from France, Germany, Belgium, Switzerland, Japan, Philadelphia, South Carolina, Antigua, Brazil.

11. **C. rubens** Lister Mycetozoa, 123 (1894) (red). Plasmodium watery-white. Total height 1 to 2 mm. Sporangia scattered, obovoid, ellipsoid or subglobose, stalked, erect or inclined, 0·5 to 0·8 mm. long, 0·3 to 0·5 broad, pinkish-brown, shining below; sporangium-wall evanescent above, membranous and persistent in the lower quarter, pinkish-brown. Stalk setaceous, black, shining, 0·6 to 1·3 mm. long, rising from a circular brown hypothallus. Columella reaching to about two-thirds the height of the sporangium, branching at the apex. Capillitium of purplish-brown threads, springing from all parts of the columella, broad at the base, more or less flexuose, anastomosing and branching at wide angles, often with flat expansions, gradually narrowing to the slender straight free ends; the persistent base of the sporangium-wall is connected with the lower part of the columella by capillitium threads with broad attachments. Spores pale lilac-brown, minutely spinulose, 7 to 8 μ diam.—Torrend Fl. Myx., 138; Macbr. N. Am. Slime-Moulds, ed. 2, 183.

Pl. 127.—*d.* sporangia (England); *e.* columella and capillitium, with the persistent base of the sporangium-wall; *f.* spore.

Closely allied to *C. pulchella*, but differing in shape, in the branching of the capillitium, and in the persistent base of the sporangium-wall, a character showing an approach to the genus *Lamproderma*. In some years it has been found in great abundance on decaying ivy leaves near Lyme Regis.

Hab. On dead leaves: not uncommon in England in autumn and winter; recorded from Devon, Dorset, Isle of Wight, Worcestershire, Bedfordshire, Surrey, Essex, Yorks, Aberdeenshire, Nairnshire, Switzerland, Pennsylvania, Colorado.

12. **C. longa** Peck in Rep. N. York Mus., xliii. 24 (1890). Plasmodium bright yellow. Sporangia clustered, forming large colonies hanging in long tufts, stalked, cylindrical, elongated and slender, flexuose or drooping, 2 to 5 cm. long, black; sporangium-wall evanescent. Stalks very slender, 1 to 3 mm. long, black, rising from a well-developed membranous hypothallus. Columella continued to near the apex of the sporangium, very slender and wavy with zigzag lines in the upper part, tapering in breadth from 20 μ at the base to 2 μ near the summit. Capillitium a lax network of dark brown threads, the terminal branchlets directed outwards, rigid, free, forking at an acute angle. Spores dark grey, spinulose, the spines connected at their bases by faint bands

forming a close reticulation, 8 to 9 μ diam. —Macbr. N. Am. Slime-Moulds, ed. 2, 175; Petch in Ann. Perad., iv. 353; A. R. Sanderson in Tr. Br. Myc. Soc., vii. 248. *Stemonitis longa* Mass. Mon., 83 (1892). *Comatricha equinoctialis* Torrend Fl. Myx., 138 (1909).

Var. **flaccida** Minakata in litt. Sporangia weak, adhering; capillitium scanty.

Pl. 122.—*a*, *b*. sporangia (Philadelphia); *c*. capillitium from upper part of sporangium; *d*. capillitium from lower part of sporangium; *e*. spores.

From the absence of any surface net in the capillitium this species is placed in *Comatricha*, though in its fasciculate habit it resembles a *Stemonitis*. The capillitium varies in different gatherings; in some the threads are comparatively short, rigid throughout, and anastomosing but little; in others they form a profuse network with many membranous expansions and very slender free branchlets; the character of the dark reticulated spores remains constant in all forms.

Hab. On dead wood: abundant in warm temperate and tropical regions; recorded also from near Berlin (in a glass-house), from Roumania, the Cape, Japan, Ottawa, and the United States, where it is more common in the east than the west.

13. **C. irregularis** Rex in Proc. Acad. Nat. Sci. Phil. 1891, 393. Plasmodium? Sporangia crowded, stalked, cylindrical, 2 to 5 mm. high, blackish-brown. Stalks black, slender, 1 to 3 mm. high, rising from a membranous hypothallus. Columella straight or flexuose, reaching nearly to the apex of the sporangium. Capillitium a close or lax network of arched purple-brown threads, becoming more slender towards the surface of the sporangium, and there forming an irregular net, or ending in numerous colourless free branchlets. Spores brownish-purple, often paler on one side, closely spinulose, 8 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 176. *Stemonitis crypta* Schwein. in Trans. Amer. Phil. Soc., iv. 260 (1832)? *Comatricha crypta* Macbr. in Bull. Nat. Hist. Iowa, ii. 139 (1893). *C. longa* var. *irregularis* Lister Mycetozoa, 120 (1894).

Pl. 122.—*f*. sporangia (Philadelphia); *g*. capillitium; *h*. spore of usual type; *i*. spore showing a faint reticulation.

This species is closely allied to *C. longa*, with which it is almost connected by intermediate forms. It has been suggested that *Stemonitis crypta* Schwein. was the present species, but the type specimen is utterly lost (*teste* Rex), and the description is too vague to be instructive.

Hab. On dead wood.—Malaya, New South Wales, Ottawa, Manitoba, and throughout the United States.

Genus 21.—**ENERTHENEMA** Bowman in Trans. Linn. Soc., xvi. 152 (1830) (ἔνερθε beneath, νῆμα thread). Sporangia stalked; columella reaching to the summit of the sporangium; capillitium springing from beneath the superficially extended apex of the columella.

1. **E. papillatum** Rost. Mon., App. 28 (1876) (*papilla*

nipple). Plasmodium watery-white. Total height 1 to 1·5 mm. Sporangia gregarious, globose, stalked, 0·5 to 0·75 mm. diam., black or purple-brown, crowned with the small shining salver-shaped rarely papillate apex of the columella; sporangium-wall evanescent. Stalk cylindrical or conical, black. Columella slender, cylindrical from a conical base, traversing the sporangium and expanding on the surface into a membranous disc 0·1 to 0·2 mm. broad. Capillitium threads spreading from the expanded apex of the columella, long, slender, black, sparingly branched, straight or flexuose. Spores greyish-brown, spinulose, 8 to 11 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 190. *Stemonitis papillata* Pers. in Roemer N. Mag. Bot., 90, t. 1, fig. 4 (1794). *S. mammosa* Fr. Syst. Myc., iii. 161 (1829). *Arcyria atra* Schum. Enum. Pl. Saell., ii. 215 (1803). *Trichia notata* Schum. l.c., 211 (young stage). *Enerthenema elegans* Bowm. l.c., t. 16; Berk. & Br. in Ann. Mag. Nat. Hist., ser. 2, v. 366; Rost. Mon., 209; Mass. Mon., 105; Lister Mycetozoa, 124. *Ancyrophorus crassipes* Raunkiaer in Bot. Tidssk., xvii. 93 (1888); Mass. l.c., 107.

Var. **carneo-griseum** Meylan in Bull. Soc. Vaud. Sc. Nat., li. 268 (1917) (greyish-flesh-colour). Spores greyish-lilac in mass.

Var. **syncarpon** G. Lister (*σύν* together, *καρπός* fruit). Spores clustered in groups of 4–8, 11–12 μ diam.—*Enerthenema syncarpon* Sturgis in Colo. Coll. Publ., Sc. Ser., xii. 448 (1913). *E. Berkeleyana* Rost. l.c., 29 ? Mass. l.c., 106 ? Macbr. l.c., 190.

Pl. 128.—*a*. sporangia (England); *b*. sporangia after dispersion of spores, showing the capillitium arising from the apical disc of the columella; *c*. sporangium with capillitium arising from the whole length of the columella, found in company with sporangia having normal capillitium; *d*, *e*. spores.

If young sporangia are disturbed while developing the capillitium often varies considerably from the normal character, and the threads, instead of being simple and radiating from the apex of the sporangium, become much branched and spring from all parts of the columella which may end below the summit; all conditions between this and the normal form occur in the same group of sporangia. The account and figure of *Ancyrophorus crassipes* Raunkiaer, well represent this irregular form. In what remains of the type of *E. Berkeleyana* Rost., from South Carolina (K. 1643), no spores of an *Enerthenema* can be detected; the specimen is sprinkled with clusters of brown spores or dividing cells of a fungus. Berkeley and Broome describe this specimen as having the 'spores produced in little heads surrounded by a common vesicle at the free apices of the flocci', and of this being 'almost the only case in which the spores of a Myxogaster have been observed *in situ*'. The sporangia are of the typical form of *E. papillatum*, and it is possible that the fungus was mistaken by Berkeley and Broome for the true spores. The occurrence, however, of clustered spores in the specimen from Colorado, named *E. syncarpon* by Dr. Sturgis, is strongly in favour of Berkeley's description of clustered spores in the S. Carolina specimen having been correct. Other characters being similar, the cohesion of spores in clusters appears to be of no more than varietal importance.

Hab. On dead wood, or on mossy bark of living trees; frequent in the British Isles in autumn and winter, and widely distributed in North Temperate regions; recorded also from South Chili; var. *syncarpon* from near Boston and Colorado.

Genus 22.—**LAMPRODERMA** Rostafinski Versuch, 7 (1873) (λαμπρός bright, δέρμα skin). Sporangia usually stalked, globose or ellipsoid (sessile in *L. insessum* and *L. atrosporum* var. *debile*); sporangium-wall membranous, somewhat persistent, shining with iridescent colours; stalk black; columella cylindrical or clavate, usually reaching to half or more than half the height of the sporangium; capillitium consisting of branched anastomosing threads, radiating chiefly from the upper part of the columella.

KEY TO THE SPECIES OF *LAMPRODERMA*.

A. Spores more or less spinulose :—

A. Spores echinulate, 15 to 20 μ diam.

Sporangia stalked. 1. *L. echinulatum*

Sporangia sessile. 2. *L. insessum*

B. Spores spinulose, warted or nearly smooth (see also 10).

a. Columella dividing above into the few primary branches of the dark flexuose capillitium. 3. *L. arcyrionema*

b. Sporangia iridescent; capillitium spreading in very numerous branches from the abruptly ending columella—

Sporangia globose; capillitium threads dark with pale bases. 4. *L. scintillans*

Sporangia globose or obovoid; stalk 3 mm. long or less; capillitium usually purple with colourless tips. 5. *L. columbinum*

Sporangia globose or ovoid; stalks 1 mm. long or less; capillitium pale or dark 6. *L. violaceum*

c. Sporangia silvery, spotted with black; capillitium pale. 7. *L. Gulielmae*

B. Spores more or less reticulated :—

Spores reticulated with raised bands. 8. *L. cribrarioides*

Spores marked with broad warts and short ridges. 9. *L. cristatum*

Spores marked with a close imperfect reticulation of raised bands or rows of warts, or spinulose or minutely warted all over. 10. *L. atrosporum*

1. **L. echinulatum** Rost. Mon., App. 25 (1876) (*echinus* sea-urchin). Plasmodium opaque white. Total height 2 to 4 mm. Sporangia loosely clustered, globose, stalked, erect, 0·5 to 1 mm. diam., shining with steel-blue or green reflections; sporangium-wall membranous, persistent, purplish or grey. Stalk subulate or cylindrical, 1 to 2·7 mm. long, black, rising from a well-developed hypothallus. Columella cylindrical, obtuse, about half the height of the sporangium. Capillitium either black, pale purplish-brown, or nearly colourless, spreading chiefly from the upper part of the columella, threads stout, sparingly forked and anastomosing, colourless and slender at the tips. Spores dark grey or brownish-purple, echinulate with black spines, 15 to 20 μ diam.—Lister in Journ. Bot., xxix. 261; Mass. Mon., 97; R. E. Fries in Svensk. Bot. Tidskr., vi. 768. *Stemonitis echinulata* Berk. in Hooker Fl. Tasm., ii. 268 (1860). *Lamproderma Listeri* Mass. l.c. (1892).

Pl. 134.—*a*. sporangia (New Zealand); *b*. columella of same; *c*. sporangia (Tasmania); *d*. columella and capillitium of same; *e*. capillitium threads; *f*, *g*. spores; *h*. sporangia (Moffat, Scotland); *i*. columella and capillitium; *k*. capillitium-threads.

The type specimen from Tasmania is an abnormal development; many of the stalks are misshapen and tumid, and most of the primary branches of the capillitium soon divide into a flaccid network of grey threads with broad expansions at the angles; but some of the primary threads are regular and branch towards the surface in the manner usual in *Lamproderma*. A specimen from New Zealand gathered by Colenso (B.M. slide) is mouldy and difficult to examine, but the capillitium forms more of a brush and resembles the British gatherings, which are perfect developments. Occasionally the capillitium threads consist of a darker central strand surrounded by a colourless sheath, which breaks up into segments as in *Collo-derma*.

Hab. On dead wood.—Dorset, Derbyshire, Yorkshire, North Wales, Wigtownshire, Aberdeenshire, Nairnshire, Co. Down, Co. Galway, Sweden, Tasmania, New Zealand.

2. **L. insessum** G. Lister in Trans. Br. Myc. Soc., iv. 41, pl. 1, fig. 2, 2*a*, *b* (1912) (perched). Plasmodium ? Sporangia clustered, sessile, subglobose or forming short plasmodiocarps, iridescent purple, 0·8 mm. diam.; sporangium-wall membranous, pale purple. Columella none. Capillitium a scanty very loose network of broad purplish threads, often expanded at the angles, and marked with a few bead-like thickenings. Spores dark brownish-purple, closely spinulose, 18 to 19 μ diam.

Pl. 215.—*e*. group of sporangia; *f*. capillitium and spores.

A single gathering only of this inconspicuous species has been recorded; it occurred on lichen (*Physcia* sp.) growing five feet from the ground, on the trunk of a living sycamore near Forres, N.B., in Sept. 1912. The unusual habitat may account for the apparent rarity of the species.

Hab. On lichen on living trees.—Elginshire.

3. **L. arcyrionema** Rost. Mon., 208 (1875) (*Arcyria* and

νῆμα thread). Plasmodium watery-white. Total height 1 to 2 mm. Sporangia gregarious, globose, stalked, erect, 0·5 mm. diam., steel-grey, blue or bronze, shining iridescent; sporangium-wall membranous, pale purple, falling away in large fragments, persistent as a collar round the base of the sporangium. Stalk subulate-setaceous, about 1 mm. high, black, shining. Columella slender, smooth, cylindrical, reaching to one-third or one-half the height of the sporangium, suddenly dividing at the apex into the few primary branches of the capillitium. Capillitium of purple-brown or black threads arising from the apex of the columella, branching repeatedly and anastomosing to form a close crisped network, with very short free ends. Spores pale lilac-grey, very faintly warted, 6 to 8 μ diam.—Mass. Mon., 96; Macbr. N. Am. Slime-Moulds, ed. 2, 197. *Stemonitis physaroides* var. *subaeneus* Berk. in Herb. *Lamproderma subaeneum* Mass. l.c., 95 (1892). *L. inconspicuum* Racib. in Hedw., xxxv. 208 (1896)? *Comatricha Shimekiana* Macbr. in Bull. Nat. Hist. Iowa, ii. 380, t. x, fig. 3 (1893).

Pl. 129.—*a*. sporangia (Philadelphia); *b*. capillitium; *c*. sporangia (England); *d*. columella and capillitium of same; *e*. spore.

This widely distributed species appears to be especially abundant in the United States, where it is described by Dr. Rex as sometimes occurring in vast profusion, 'covering one entire side of a fallen log about 3 feet in diameter for a length of about 10 feet with the steel-coloured sporangia'. The specimens marked *Stemonitis physaroides* var. *subaeneus*, from Ohio, in Berkeley's collection (K. 1560, 1562) correspond in every respect with Rostafinski's type of *Lamproderma arcyrionema* in Strasb. Herb. *Comatricha Shimekiana* Macbr., from Nicaragua (B.M. 1008), is a form of the present species with rather slender capillitium. The sporangia of *L. arcyrionema* are on the whole remarkably constant in character. A variety has been found near Kamawata, Japan, by Mr. K. Minakata (B.M. 2659), with unusually lax and slender capillitium, and with spores rather darker than in the typical form measuring 8 to 9 μ diam.

Hab. On dead wood: not common in Britain; recorded from Cornwall, Devon, Somerset, Worcestershire, Bedfordshire, Middlesex, Essex, Norfolk, Yorkshire, and South Wales; from France, Poland, Roumania, Switzerland, Portugal, South Nigeria, Ceylon, East and West Indies, Japan, United States, Brazil.

4. **L. scintillans** Morgan in Journ. Cinc. Soc. Nat. Hist., xvi. 131 (1894) (sparkling). Plasmodium watery-white. Total height 1 to 1·5 mm. Sporangia scattered or gregarious, globose, stalked, erect, 0·3 to 0·5 mm. diam., steel-blue, red or bronze, brilliantly iridescent; sporangium-wall delicately membranous, colourless, falling away in large fragments. Stalk setaceous, black, shining, rising from a purple-brown circular hypothallus. Columella cylindrical, truncate, scarcely reaching to half the height of the sporangium. Capillitium of rigid threads, radiating from the apex of the columella, dichotomously branching and anastomosing, black or purple-

brown, pale at the base, coloured to the free extremities ; the threads connecting the apex of the columella with the somewhat persistent base of the sporangium-wall usually slender and colourless. Spores violet-grey, minutely warted, 6·5 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 195. *Stemonitis scintillans* Berk. & Br. in Journ. Linn. Soc., xv. 84 (1876). *Lamproderma arcyrioides* var. *iridea* Cooke Myx. Brit., 50 (1877). *L. irideum* Mass. Mon., 95 (1892) ; Lister Mycetozoa, 128. *Enerthenema muscorum* Lév. in Ann. Sci. Nat., ser. 4, xx. 289 (1863).

Pl. 130.—*a*, *b*. sporangia (England) ; *c*. capillitium and columella ; *d*. branching thread of capillitium showing the colourless base ; *e*, *f*. spores.

This species is distinguished from *L. violaceum* by the bases of the capillitium threads being pale where they spring from the truncate apex of the columella, and by the spores, which, instead of being minutely and closely spinulose as in the pale-spored form of *L. violaceum*, are marked with scattered warts that can easily be counted when magnified 1,000 diam., and number about thirty on the hemisphere. It is a most abundant species in England in heaps of dead leaves ; in a fir plantation near Lyme Regis the stones and herbage by the side of a rivulet and rising from the water appeared hoary over an area of many square yards with the young rising sporangia. The type from Ceylon (K. 1634) agrees in all characters with the English gatherings, and is well described by Berkeley. There are several specimens of this species in the Kew Collection, named *L. arcyrioides* var. *iridea* Cke. (K. 615–19) ; these are referred to in Massee's Monograph as having smooth spores measuring 11 to 16 μ, which is misleading. The type of *Enerthenema muscorum* Lév. from New Granada (B.M. 1032), appears to be a form of the present species ; it is on moss, and consists of scattered sporangia on setaceous stalks, with rigid capillitium threads dark to the base ; the spores measure 7·5 to 9 μ, and are marked with fewer and larger warts than in the type. Considering the unusual character of the gathering it seems better to retain Berkeley's specific name for the present species, rather than revive that given by Léveillé, although the latter is of earlier date.

Hab. On dead leaves, twigs, and straw : common in the British Isles from summer to early spring ; widely distributed, especially in temperate regions ; recorded also from Ceylon, Singapore, and Java ; not common in the United States.

5. **L. columbinum** Rost. Versuch, 7 (1873) (dove-coloured, from the sporangia having the iridescence of a pigeon's neck). Plasmodium opaque white, rarely yellow. Total height 2 to 3 mm. Sporangia gregarious, globose or ellipsoid, stalked, erect, 0·5 to 0·8 mm. diam., purplish-black with iridescent blue or green reflections, or shining like burnished brass ; sporangium-wall membranous, persistent, purplish in the lower part, usually mottled with darker shades. Stalk cylindrical, straight, 1·5 to 2 mm. high, 0·15 mm. thick, purplish-black, shining, longitudinally striate or rugose, rising from a dark purplish hypothallus. Columella cylindrical with a conical apex, or clavate, reaching to more than half the height of the sporangium. Capillitium dense of brownish-

purple threads, radiating from the columella, sparingly forked and anastomosing, towards the surface branching and forming a delicate, nearly colourless network. Spores purple-grey, closely spinulose, 11 to 14, rarely 16 μ diam.—Rost. Mon., 203 ; Mass. Mon., 100 ; Macbr. N. Am. Slime-Moulds, ed. 2, 194. *Physarum columbinum* Pers. Obs. Myc., i. 5 (1796) ; Fr. Syst. Myc., iii. 136. *P. salicinum* Schum. Enum. Pl. Saell., ii. 200 (1803) ? *P. bryophilum* Fr. l.c., 135 (1829) ? *Stemonitis physaroides* Alb. & Schw. Consp. Fung., 103, t. 11, fig. 8 (1805) ? *Trichia columbina* Poiret in Lam. Encycl., viii. 52 (1808). *Fulgia encaustica* Chev. Fl. Par., ed. 2, 347 (1836). *Lamproderma physaroides* Rost. l.c., 202 ; Mass. l.c., 103 ; Lister Mycetozoa, 125 ; Macbr. l.c., 192. *L. Schimperi* Rost. l.c., 203.

Var. **gracile** G. Lister (slender). Plasmodium watery-white. Sporangia obovoid-cylindrical, obovoid or subglobose, iridescent blue or violet ; stalk 2 to 3 mm. long, slender, subulate, often curved.

Var. **iridescens** G. Lister in Trans. Br. Myc. Soc., ix. 36 (1923). Sporangia globose ; stalks stout, long or short ; capillitium lax, colourless or pale purplish.—*Physarum iridescens* Berk. in Hook. Journ. Bot., iii. 20 (1851). *Lamproderma iridescens* Rost. l.c., App. 25 (1876).

Var. **brevipes** G. Lister l.c. (*brevis* short, *pes* foot). Plasmodium watery-white or yellow. Sporangia globose, iridescent or dull glossy ; stalks 0·3 to 0·5 mm. long, usually slender ; capillitium of purplish threads which are tubular, flattened, and often mottled below, branching and forming an irregular network above, often with dark expansions at the axils.—*L. Staszcii* Racib. in Hedw. xxviii. 116 (1886) ? *L. Cruchetii* Meylan in Bull. Soc. Vaud. Sc. Nat., lii. 96 (1918) ?

Pl. 131.—*a.* sporangia of typical form ; *b, c, d.* sporangia of var. *gracile* ; *e, f.* capillitium of subglobose and cylindrical sporangia ; *g.* capillitium from base of sporangium, and columella ; *k.* columellae of various shapes from one group of sporangia ; *l, m.* spores.

This beautiful and widely distributed species varies much in the shape of the sporangium and in the colour of the capillitium, while the spores are remarkably constant in character. The typical form, with brilliantly iridescent blue or brassy globose sporangia and straight cylindrical stalks, is the most abundant form in Britain, and occurs on fir wood ; var. *gracile* with usually longer, iridescent blue sporangia and long slender curved stalks, is not uncommon on mossy pine stumps. Both these forms have normally a cylindrical columella and close regularly branched dark capillitium, ending at the surface in a dense brush or pile of very slender colourless branchlets ; imperfect developments often have a clavate or bulbous columella. The vars. *iridescens* and *brevipes* appear to be weaker forms, and usually occur on moss on wet rocks, but sometimes on decayed fir wood. The type of var. *iridescens* is an almost sessile form with weak colourless capillitium, found by the late Richard Spruce on liverwort in the Pyrenees in 1851 (K. 1318) ; sporangia with similar capillitium and either short or long stalks are not unfrequent on mossy rocks in North Wales.

The var. *brevipes* is a more widely distributed and commoner form, with short slender stalks and with the dark capillitium often knotted with irregular expansions at the axils of the branches. All these forms appear to merge into one another, and defy attempts to divide them into distinct species. M. Meylan has published a new species, *L. Cruchetii*, from the Jura Mountains, differing from var. *brevipes* only in the yellow colour of the plasmodium; but as typical *L. columbinum* sometimes has yellow plasmodium it seems doubtful if *L. Cruchetii* deserves specific rank. The description and illustration of *Stemonitis physaroides* Alb. & Schw., with globose shining silvery-grey sporangia and compact globular capillitium, suggest *L. arcyrionema* rather than the present species, but in the absence of the type this reference is conjectural. The specimen in the Strasburg Herbarium of *L. physaroides* agrees in all respects with the above description of typical *L. columbinum*. There are three specimens in that collection determined by Rostafinski as *L. columbinum*; one is the present species, one is a pale form of *L. violaceum*, and the third is *L. scintillans*.

Hab. On decayed fir wood and moss: the typical form and var. *gracile* are widely distributed in North Temperate regions; var. *gracile* has also been recorded from Tasmania: var. *iridescens* recorded from North Wales, Aberdeenshire, and the Pyrenees: var. *brevipes* recorded from Somerset, Cumberland, Northumberland, North Wales, Aberdeenshire, Co. Dublin, Vosges and Jura Mountains, and from near Berlin.

6. **L. violaceum** Rost. Versuch, 7 (1873). Plasmodium watery-white, rarely yellow. Total height 0·6 to 1·5 mm. Sporangia stalked, subglobose, more or less flattened and umbilicate beneath, erect, scattered or gregarious, 0·4 to 0·9 mm. diam., shining with iridescent blue, violet or bronze reflections; sporangium-wall membranous, somewhat persistent, colourless or pale violet-brown, often sprinkled with small scattered clusters of slender hyaline rods, 50 to 100 μ long, which appear to be of a crystalloid nature. Stalk varying from very short to one and a half times the height of the sporangium, black, rising from a red-brown membranous hypothallus. Columella one-third to two-thirds the height of the sporangium, cylindrical, obtuse, or sometimes narrowing to the apex. Capillitium of almost colourless or brown threads springing from the upper part of the columella, branching and anastomosing to form a more or less dense network, becoming very slender towards the surface. Spores purplish-grey, minutely spinulose, 8 to 10 μ diam.—Rost. in Fuckel Symb. Fung., Nachtr. 69; Mon., 204; Mass. Mon., 94; Macbr. in N. Am. Slime-Moulds, ed. 2, 196. *Stemonitis violacea* Fr. Syst. Myc., iii. 162 (1829). *S. arcyrioides* Somm. in Mag. Nat., vii. 298 (1827). *Lamproderma arcyrioides* Rost. l.c., 206; Blytt in Bidr. K. Norg., Sop. iii. 8; Mass. l.c., 102. *L. nigrescens* Rost. l.c., 205 (1875)? *L. leucosporum* Rost. l.c., App. 26 (1876)? *L. minutum* Rost. l.c.? *L. nigrescens* Sacc. in Michelia, ii. 262 (1882) (*non* Rost.). *L. tatricum* Racib. in Hedw., xxviii. 117 (1889)? *L. Saccardianum* Mass. l.c., 101 (1892). *Tilmadoche Berkeleyi* Mass. l.c., 332.

Var. **Sauteri** Lister Mycetozoa, 129 (1894) (Dr. Sauter who found this variety near Salzburg in 1863). Sporangia globose, or ovoid-globose; capillitium threads straight or rather wavy, brown; spores purple-brown, 11 to 15 μ diam., nearly smooth or spinose.—*L. Sauteri* Rost. Mon., 205 (1875); Meylan in Bull. Soc. Vaud. Sc. Nat., li. 268; Macbr. N. Am. Slime-Moulds, 140. *L. robustum* Ellis & Everh. in Mass. Mon., 99 (1892); Macbr. l.c., ed. 2, 193. *L. arcyrioides* Morg. in Journ. Cinc. Soc. Nat. Hist., xvi. 131 (1894). *Stemonitis Morthieri* Fuckel Symb. Myc., 343 (1869).

Var. **Carestiae** Lister l.c., 130 (Abbé A. Carestia who gathered this form in Piedmont in 1861). Sporangia globose or ovoid, nearly black, shortly stalked or sessile on a dark membranous hypothallus; capillitium of dark purple-brown threads with colourless tips, either flexuose and forming a dense network, or almost straight and branching at acute angles; spores purple-brown, closely spinulose or spinose, 9 to 20 μ diam.—*Stemonitis Carestiae* Ces. & de Not. Erb. Crit. Ital., no. 888 (1879).

Pl. 132.—*a*, *b*. sporangia (England); *c*. capillitium and columella; *d*, *e*. spores; *f*. sporangium of var. *Sauteri* (Salzburg); *g*, *m*. spores of same; *h*. sporangia of var. *Carestiae* (North Italy); *i*. capillitium and columella of same; *k*, *l*. spores of same.

The varieties given above are well-marked centres, round which intermediate forms group themselves, but neither the size of the spores, the colour of the capillitium, nor the shape of the sporangia can be taken as giving constant specific characters. The typical form is usually found in the lowlands; the two well-marked varieties are essentially alpine forms. Gatherings made near Lyme Regis show even in a single development capillitium varying from nearly colourless and flaccid, to brown and rigid, the associated spores being pale violet-grey, closely and minutely spinulose, 8 to 10 μ diam. The type of *S. arcyrioides*, of which through the courtesy of Prof. Blytt of Christiania a mounting is in the British Museum, has globose sporangia, with brown capillitium and minutely spinulose spores 8 to 9 μ diam., as in typical *L. violaceum*. The measurement '12·5 to 16·5 μ' given by Rostafinski and repeated in other works is erroneous, but is corrected by Prof. Blytt, l.c. By the strict application of the rule of priority, the name *L. arcyrioides* should take precedence of *L. violaceum*, but the former has been so long associated with a misleading description that it would seem preferable to retain the familiar and appropriate name given by Fries. The type of *L. Sauteri* Rost. from Salzburg in the Tyrol, now in the Strasburg Herbarium, has the same form of sporangium and abundant brown capillitium as in the type of *S. arcyrioides*, but has spinulose spores, 11 to 14 μ diam. The type of *Lamproderma robustum* Ellis and Everh., from Philadelphia (B.M. slide), is var. *Sauteri* with dark, strongly spinulose spores 11 to 13 μ diam.; it is almost identical with the type of *L. Sauteri*. In some gatherings of var. *Carestiae* the spores measure 9 μ, in others 11 to 14 μ, in others again 14 to 20 μ; they are usually dark purplish-brown, and either nearly smooth or strongly spinulose. Interesting light is thrown on the strange variety of forms which may occur in this species by the study of a single development found on the Weissenstein, Jura Mountains, 4,000 ft. alt., in June 1910. The sporangia are 0·9 to 1·3 mm. diam., subglobose and shortly stalked or sessile, and either brilliant iridescent blue or dull glossy bronze in colour. The walls of the iridescent sporangia are membranous and pale purplish, entirely free from refuse-

matter of any kind; in the bronze form the sporangium-walls include much brown granular refuse-matter, evenly distributed or forming irregular lumps and patches; in the stalked sporangia the columellae, and capillitium of slender almost colourless flaccid threads are, on the whole normal; but amongst the sessile sporangia a few ring-shaped plasmodiocarps occur, with walls more or less clothed with refuse-matter, the columella forming an irregular low ridge, and capillitium consisting of a dense network of pale slender threads branching mostly at right angles, enclosing meshes 15 to 70 μ diam. In all these sporangia the spores are purplish-grey, minutely spinulose and 9 to 10 μ diam., as in the typical form.

Hab. On mossy wood, dead leaves, and twigs: the typical form is fairly abundant in Great Britain, widely distributed throughout Europe, and common in the United States; it has also been recorded from Tasmania: vars. *Sauteri* and *Carestiae* occur on turf and hollow herbaceous stalks in alpine situations; they have been recorded from Scotland, Germany, and North Italy; they are abundant in Sweden and the Swiss Alps; var. *Sauteri* has also been recorded from the western United States.

7. **L. Gulielmae** Meylan in Bull. Soc. Vaud. Sc. Nat., lii. 449 (1919) (Gulielma Lister). Plasmodium 'translucent yellow' (Brandza). Sporangia globose or obovoid, stalked, in loose clusters, 0·35 to 0·45 mm. diam., silvery or iridescent blue, spotted with black depressed patches corresponding to thickened purplish-brown areas of the otherwise colourless sporangium-wall. Stalk black, subulate, 0·5 to 1 mm. high. Capillitium consisting of pale brown or colourless threads radiating from the columella, and branching repeatedly at an acute angle. Spores brownish-purple, strongly spinulose, 12 to 15 μ diam.—G. Lister in Journ. Bot., lix. 91. *L. echinulatum*? Brandza in Ann. Sc. de l'Univ. de Jassy, x. 196, pl. ii, fig. 3 (1916).

Pl. 215.—*a.* sporangia; *b.* sporangium after spore dispersal; *c.* branch of capillitium; *d.* spore.

This widely distributed species was first described by Prof. Marcel Brandza from luxuriant colonies found by him on dead beech leaves in mountain woods in Moldavia; he suggested it might be a form of *L. echinulatum*, but describes and figures the spores as closely reticulated; unfortunately all his first gatherings were destroyed during the war; later specimens collected by him have strongly spinulose spores as in M. Ch. Meylan's type of *L. Gulielmae* from Côte aux Fées in the Jura Mountains. The spotted character of the sporangium enables this species to be identified even in the field with the aid of a pocket lens.

Hab. On dead leaves of beech and on needles of conifers.—Norfolk, Aberdeenshire, Jura Mountains and Mürren, Switzerland, Moldavia, and Colorado.

8. **L. cribrarioides** R. E. Fries in Svensk. Bot. Tidskr., iv. 259 (1910) (*Cribraria*). Plasmodium ? Sporangia scattered or clustered, globose, 0·8 mm. diam., stalked or sessile, rarely forming plasmodiocarps, purple-brown, shining with iridescent colours; sporangium-wall membranous, colourless above, purplish-brown below. Stalk black, 0·1 to 0·5 mm. high. Columella cylindrical, reaching to half or two-thirds the

height of the sporangium, absent in the plasmodiocarp form. Capillitium a network of pale or dark purplish-brown flexuose threads, which are stouter below, slender and colourless at the tips. Spores brownish-purple, 11 to 18 μ diam., regularly reticulated with narrow raised bands that form a net with from 8 to 24 meshes on the hemisphere, and show as a border 0·5 to 1·5 μ wide.—R. E. Fr. l.c., vi. 768; Meylan in Bull. Soc. Vaud. Sc. Nat., li. 264. *Stemonitis cribrarioides* Fr. Syst. Myc., iii. 163 (1829). *Lamproderma Lycopodii* Raunk. in Bot. Tidsskr., xvii. 109 (1888); Lister in Journ. Bot., xlvi. 218.

Pl. 133.—*a*. plasmodiocarp (Switzerland); *b*, *c*. capillitium; *d*, *e*. spores.

Dr. R. E. Fries has examined the type of *Stemonitis cribrarioides* Fr., gathered near Arnstadt, Thuringia, on *Lycopodium annotinum* by Lucas, and preserved in the Botanical Museum, Upsala, and finds it corresponds perfectly with specimens obtained by himself in Lappmark on dead stalks of *Mulgedium alpinum*; it is also similar to the type of *L. Lycopodii* Raunkiaer, which was found on the island of Zealand, Denmark, on *Lycopodium annotinum*. *L. cribrarioides* occurred on the Col de Venosc in Dauphiné, near melting snow, in May 1922, scattered over the large irregular nodules formed by the sclerotium of *Diderma Lyallii*. M. Meylan finds it common and 'in numerous forms' on leaves and twigs high on Jura Mountains in springtime. A curious pulvinate plasmodiocarp form was found by Dr. A. Volkart on the Fürstenalp, Graubunden, 1,700 m. alt., scattered over a spray of *Lycopodium alpinum*; no columella is developed, and the dense network of pale brown capillitium arises from the whole of the shining reddish-brown floor of the sporangium. On the same spray of *Lycopodium* were sporangia of *L. violaceum* var. *Carestiae*, suggesting, at first sight, that all these sporangia might be variants of the same species. A fine colony of *L. cribrarioides* was found in October 1922 by Miss A. M. Davidson on a pine stump in Hazelhead Wood near Aberdeen. This species resembles *L. violaceum* var. *Sauteri* in capillitium and general appearance and differs chiefly in the sharply defined reticulation of the spores.

Hab. On pine stumps: also on *Lycopodium*, dead leaves, twigs, &c., on moorland and in alpine meadows.—Aberdeenshire, North Sweden, Island of Zealand, Thuringia, Dauphiné, Switzerland, Austria.

9. **L. cristatum** Meylan in Bull. Soc. Vaud. Sc. Nat., liii. 457 (1921) (crested). Plasmodium ? Sporangia crowded or scattered, shortly stalked or sessile on a membranous hypothallus, subglobose or ovoid, 1 to 1·5 mm. diam., silvery iridescent. Capillitium either brown, radiating in somewhat wavy lines from the columella, as in *L. violaceum* var. *Sauteri*, or forming a dense network of dark threads with colourless tips, as in *L. violaceum* var. *Carestiae*. Spores dark brownish-purple in mass, marked with short broad flat-topped warts or short ridges, 11 to 15 μ, purple-grey.

Pl. 216.—*h*. spores.

This alpine species has been found in some abundance by M. Meylan, in four different localities during the last four years in the Jura Mountains near Ste. Croix. Although the capillitium may vary considerably even in a single development, the spores retain their characteristic markings. These, as M. Meylan points out, resemble those on the spores of *Trichia*

persimilis; under a high magnification the broad warts and ridges are seen to be hollow membranous vesicles enclosing air and marked along their crests by small papillae.

Hab. On leaves, twigs, &c., near melting snow.—Jura Mountains.

10. **L. atrosporum** Meylan in Bull. Soc. Vaud. Sc. Nat., xlvi. 51 (1910) (*ater* black, σπορά seed). Plasmodium ? Sporangia clustered or scattered, subglobose or ovoid, stalked or sessile, glossy purple-black with silvery or iridescent reflections, 0·8 to 1·4 mm. diam.; sporangium-wall purplish, at length breaking up into fragments. Stalks black, 0·1 to 1 mm. high, on a dark membranous hypothallus. Columella cylindrical or clavate, about half the height of the sporangium. Capillitium consisting of nearly black or purple-brown threads, branched and anastomosing, slightly flexuose or closely crisped, dark to the tips of the branchlets which are often thickened and adhere to the sporangium-wall. Spores brownish-purple or purplish-grey, 11 to 15 μ diam., either closely and minutely spinulose, or marked with scattered spines, or more or less completely reticulated with rows of minute warts or raised bands.

Var. **anglicum** G. Lister & Howard in Journ. Bot., lvii. 27 (1919) (English). Sporangia shortly stalked or sessile, clustered or scattered, narrowly obovoid, ovoid or subglobose, 0·5 to 0·6 mm. diam., dark purple-brown with iridescent blue reflections; sporangium-wall purplish-brown. Stalk slender, 0·1 to 0·3 mm. high. Columella long, slender, and cylindrical, or clavate, irregular and merging by membranous expansions into the capillitium; capillitium threads dark to the tips of branchlets which adhere to the sporangium-wall. Spores purplish-grey, 11 to 14 μ, more or less reticulated with rows of minute warts, or raised lines, or spinose.

Var. **debile** G. Lister & Howard (weak). Sporangia clustered or scattered, sessile, subglobose or hemispherical on a membranous base, rarely forming plasmodiocarps; sporangium-wall pale purplish-brown. Columella black, shortly cylindrical, convex, or often entirely absent. Capillitium a dense network of pale purplish or colourless threads with membranous expansions at the angles. Spores purplish-grey, very pale in some specimens, closely and minutely spinulose all over, or marked with a few small scattered clusters of minute warts, 9 to 12 μ diam.—*L. violaceum* var. *debile* G. Lister & Howard in Journ. Bot., lvii. 25 (1919).

Pl. 133.—*f.* sporangia; *g.* showing capillitium after dispersion of spores; *h*, *i.* spores.
Pl. 216.—*a.* var. *anglicum*, stalked and sessile sporangia; *b.* capillitium attached by tips of branchlets to sporangium-wall; *c.* spores with broken or complete reticulation; var. *debile*, group of sporangia, one of which shows a flat base and rudimentary columella; *e*, *f.* spores from two sporangia showing variety of markings; *h.* fragment of colourless capillitium.

The typical form of this species is not unfrequent in many parts of the Swiss Alps and in the Jura Mountains. Although closely allied to *L. vio-*

laceum var. *Carestiae* and *L. cribrarioides*, it is distinguished from both by the dark tips of the capillitium threads adhering firmly to the sporangium-wall; this causes the wall to break up into many fragments and gives the unburst sporangia a less brilliant iridescent sheen than in the allied species. The var. *anglicum* was first gathered in fair abundance by Mr. H. J. Howard in heaps of dead beech leaves in a wood near Norwich, in the spring of 1918, and again in 1920, 1922, and 1923; Mr. E. Brazier found it near Stourbridge, Worcestershire, in May 1920, also on beech leaves; in every case it was associated with var. *debile*, which was the distinctly more abundant variety; in a few instances forms occurred intermediate in character. Without these intermediate forms, any connexion between the var. *debile* with its pale capillitium and spores and var. *anglicum* with dark capillitium and spores would have seemed highly improbable.

Hab. On dead beech leaves, twigs, &c., in alpine situations.—Switzerland: vars. *anglicum* and *debile* recorded from Norfolk and Worcestershire.

Genus 23.—**CLASTODERMA** Blytt in Bot. Zeit., xxxviii. 343 (1880) (κλαστός broken to pieces, δέρμα skin). Sporangia stalked, without lime; columella very short; capillitium arising from the apex of the columella as solid pale brown threads, repeatedly forking, sparingly anastomosing; sporangium-wall dividing into membranous rounded or polygonal fragments, attached to one or several of the ultimate branches of the capillitium; spores pale brown.—*ORTHOTRICHA* Wingate in Journ. Myc., ii. 125 (1886).

1. **C. Debaryanum** Blytt l.c. (Anton de Bary, 1831 to 1888, a master in the study of Mycetozoa). Plasmodium watery-white. Total height 1 to 1·25 mm. Sporangia gregarious, globose, stalked, 0·15 to 0·2 mm. diam., brown; sporangium-wall membranous, persistent only in circular or polygonal plates attached to the ultimate branches of the capillitium. Stalks slender, dark, rugose and enclosing refuse-matter below, smooth, solid, translucent brown above; about the middle there is usually a swollen shining and sticky portion enclosing refuse-matter. Columella short, dividing into the primary branches of the capillitium. Capillitium of pale brown threads, forking three or four times, sparingly anastomosing at the surface, the ultimate branchlets attached singly or two or three together to the persistent plates of the sporangium-wall. Spores pale brown, smooth, 7 to 10 μ diam.—R. E. Fries in Svensk. Bot. Tidsk., vi. 769; Macbr. N. Am. Slime-Moulds, ed. 2, 191. *Orthotricha microcephala* Wing. l.c.; Mass. Mon., 109.

Pl. 135.—*a*. sporangia (Philadelphia); *b*. sporangia after dispersion of spores; *c*. capillitium branches; *d*. capillitium with expanded membranous plates (Norway); *e*. spore; *f*. sporangium (Norway); *g*. spore (Ceylon).

This minute species was discovered by Prof. Blytt in 1879, near Christiania, growing on dead *Polyporus*. In the United States it has been repeatedly found, and was described by Mr. Wingate as *Orthotricha microcephala*. In these gatherings the threads anastomose more freely than in the Norwegian specimen, and the disc-shaped fragments of the sporangium-wall

are usually less pronounced; in some sporangia, however, they agree essentially with the type. Mr. Petch describes *Clastoderma Debaryanum* as being rather common in Ceylon 'on rotten wood in up-country jungles', but found also at lower elevations (see Petch in Ann. Perad., iv. 354).

Hab. On dead wood, gorse sticks, &c.—Somerset, Norway, Sweden, Austria, Portugal, Ceylon, Borneo, New South Wales, New Zealand, Japan, the more eastern United States and S. Chili.

Genus 24.—**ECHINOSTELIUM** de Bary in Rost. Versuch, 7 (1873) (ἐχῖνος hedgehog, στήλη column). Sporangia stalked, very minute, 50 μ diam., colourless; capillitium branches few, arising from the apex of a short columella.*

1. **E. minutum** de Bary l.c. Plasmodium colourless. Sporangia scattered, stalked, colourless, globose, 40 to 50 μ diam. Sporangium-wall persistent at the base as a minute collar. Stalk subulate, 0·4 mm. long, solid and hyaline above, enclosing nearly colourless refuse-matter below. Columella slender, 3 to 4 μ high. Capillitium of two or three colourless zigzag threads, simple or sparingly branched and anastomosing, with free spine- or hook-like branches. Spores colourless, smooth, 6 μ diam.—Rost. Mon., 215, figs. 53, 54, 58, 68; Mass. Mon., 109; Macbr. N. Am. Slime-Moulds, ed. 2, 198.

Pl. 128.—*f.* sporangia (Dumfriesshire); *g.* sporangium showing capillitium; all the spores but two are dispersed; *h.* various forms of capillitium; *i.* spores.

This inconspicuous hyaline species appears to be most nearly allied to *Clastoderma Debaryanum*. It may be easily mistaken in the field for the fruit of a *Mucor*. The spore-wall is not perfectly uniform, but is divided into areolae by thin lines of dehiscence.

Hab. On dead wood.—Herefordshire, Cheshire, Dumfriesshire, Aberdeenshire, Austria, Pennsylvania, and Massachusetts (in a culture of Prof. Thaxter's).

Genus 25.—**BARBEYELLA** Meylan in Bull. Soc. Bot. Genève, sér. 2, vi. 89 (1914), figs. 1 to 6 (M. Barbey, a Swiss botanist). Sporangia subglobose, stalked, with the dull purple walls dehiscing in lobes and somewhat persistent; capillitium of few simple black threads radiating from the summit of the columella.

1. **B. minutissima** Meylan l.c. Plasmodium ? Sporangia scattered, stalked, subglobose, angular, 0·13 to 2 mm. diam., dull blackish-purple, glossy along the angles; sporangium-walls membranous, dull purple, with scattered deposits of dark refuse-matter, breaking up into a few persistent irregular

* *Heimerlia hyalina* F. v. Höhnel (Ann. Myc., i. 391 (1903)), which has by some writers been included among the Mycetozoa, does not appear to belong to this group. Very little is known of its life-history. The minute colourless sporangia somewhat resemble those of *Echinostelium minutum* in size and shape. The slender subulate stalk penetrates the sporangium to form a long columella; there is no capillitium; the spores are held together by a drop of hyaline mucilage; they do not give rise to amoeboid bodies, but the contents consist of a long closely coiled thread; when placed in water the spore-wall bursts and the thread rapidly straightens into a non-motile rod 70 to 80 μ long, 0·2 μ wide. These observations were made on specimens that appeared on dead wood at Lyme Regis in July 1904; the further fate of the threads was not traced. It appears possible that *Endodromia vitrea* Berk. (Hook. Journ. Bot., iii. 78, t. 1, fig. *c*. (1841)) is the same species.

lobes and plates, the margins of which are slightly reflexed, thickened, and minutely papillose. Stalk black, subulate, solid above, tubular and enclosing refuse-matter below, 0·2 to 0·6 mm. high. Columella black, about half the height of the sporangium, cylindrical or thickened at the summit from which most of the few, 7 to 10, dark simple capillitium threads radiate, to adhere by their tips to the sporangium-wall. Spores pale purplish-grey, minutely warted, 7 to 8 μ.

Pl. 217.—*d*. sporangia on liverwort, two unbroken, one burst and showing capillitium; *e*. sporangium from a glycerine mounting; *f*. columella, capillitium, and part of sporangium-wall; *g*. spore.

This minute species has been found twice by M. Ch. Meylan on liverworts, near Ste. Croix in the Jura Mountains, at an altitude of over 4,000 ft. It resembles *Clastoderma* and *Echinostelium* in the stalk being solid above and enclosing refuse-matter in the lower part, but in colour is more like a *Lamproderma*.

Hab. On liverworts.—Jura Mountains.

Family III.—Amaurochaetaceae.

Sporangia combined into an aethalium. Capillitium dark purple-brown, of irregular strands and threads, or of complex vesicles.

KEY TO THE GENERA OF *AMAUROCHAETACEAE*.

Capillitium of irregularly branching threads; spores in mass black. (26) Amaurochaete

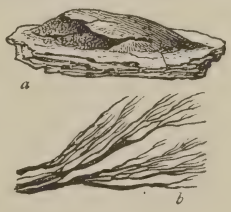


Fig. 34.—*Amaurochaete fuliginosa* Macbr.
a. Aethalium. Half natural size.
b. Capillitium. Magnified 10 times.

Fig. 34.

Capillitium of horizontal threads, with many chambered vesicles; spores in mass purple-brown. (27) Brefeldia



Fig. 35.—*Brefeldia maxima* Rost.
a. Aethalium. Natural size.
b. Capillitium and spores. Magnified 50 times.

Fig. 35

Genus 26.—**AMAUROCHAETE** Rostafinski Versuch, 8 (1873) (ἀμαυρός dark, χαίτη mane). Aethalium pulvinate, composed of elongated closely compacted confluent sporangia; sporangium-walls not developed within the aethalium. Columellae black, arising from a dark membranous hypothallus, irregularly branched and anastomosing, merging into the strands and threads of the capillitium. Spores in mass black.

KEY TO THE SPECIES OF *AMAUROCHAETE*.

Capillitium branches irregularly anastomosing.
1. *A. fuliginosa*

Capillitium an elastic network of curved threads.
2. *A. cribrosa*

1. **A. fuliginosa** Macbr. N. Am. Slime-Moulds, 109 (1899) (sooty). Plasmodium creamy-white. Aethalium pulvinate on a broad base, 1 to 8 cm. diam., rarely subglobose, 0·5 to 1 cm. diam. and attached to the substratum by a slender stalk-like strand of hypothallus, glossy purplish-black; cortex divided by thinner lines into polygonal areolae, 0·4 to 0·8 mm. diam., representing the summits of the component sporangia. Columellae of black rigid flattened strands, forked and anastomosing, arising from a dark purplish membranous base. Capillitium of irregular dark strands branching repeatedly at acute angles and anastomosing, the ultimate branchlets slender. Spores purplish-grey, paler on one side, minutely spinulose, 11 to 14 μ diam.—*Lycoperdon fuliginosum* Sow. Engl. Fung., t. 257, with description (1803). *Lycogala atrum* Alb. & Schw. Consp. Fung., 83 (1805). *Dermodium inquinans* Link in Mag. Ges. Nat. Fr. Berl., iii. 25 (1809)? *Strongylium atrum* Swartz in Hand. K. Svenska Vet. Acad., 110 (1815). *S. majus* Fr. Symb. Gast., 9 (1817). *Reticularia Strongylium* Schwein. Syn. Fung. Carol., 35 (1822). *R. atra* Fr. Syst. Myc., iii. 86 (1829). *Amaurochaete atra* Rost. Versuch, 8 (1873); Mon., 211; Mass. Mon., 89; Lister Mycetozoa, 134.

Pl. 136.—*a*. capillitium (England); *b*, *c*. spores.

Sowerby's illustration of *Lycoperdon fuliginosum* with the accompanying note so well represents the present species, that his specific name must take precedence over that of Albertini and Schweinitz. The spores when first matured are a rich brownish-purple, but in a few days they fade to dull purplish-grey when seen by transmitted light.

Hab. On dead coniferous wood: not uncommon in Great Britain and widely distributed throughout Europe, the United States, and Japan.

2. **A. cribrosa** Sturgis in Mycologia, ix. 329 (1917) (sieve-like). Plasmodium watery-white. Aethalia subglobose or pulvinate, 1 to 4 cm. diam., glossy black, sessile, rarely stalked;

sporangium-walls represented by the polygonal areolae of the purplish membranous cortex. Columellae numerous, less stout than in the preceding species, branched and anastomosing, dividing above into the capillitium which forms an elastic network of dark arcuate threads, sometimes divided or lobed towards the surface of the aethalium to show the contours of the component sporangia. Spores black in mass, purplish-grey by transmitted light with a pale area of dehiscence, closely and minutely spinulose, 11 to 15 μ.—*Lachnobolus cribrosus* Fr. Syst. Orb. Veg., 148 (1825). *Reticularia nitens* Morg. in Journ. Cinc. Soc. Nat. Hist., xviii. 40, pl. ii, fig. 11 (1895) ? *Amaurochaete Tubulina* Macbr. N. Am. Slime-Moulds, ed. 2, 150 (1922). *Matruchiotiella splendida* Skup. in Bull. Ac. Pol. Sc., 1924, 396, figs. 4 to 6.

Pl. 217.—*a*. two aethalia, one entire, the other after spore-dispersal (Vadheim); *b*. capillitium; *c*. spores.

In the former editions of this work the present species was included under *A. fuliginosa*, but gatherings from many localities show it to be a well-marked and constant form having the capillitium more fully developed and of a far more graceful type. The relation between the two forms is discussed by Fries (Syst. Myc., iii. 87), who points out their general resemblance, but draws attention to the remarkable dense woolly elastic network of '*Lachnobolus cribrosus*'. A portion of Fries's type, marked '*Lachnobolus cribrosus* ex herb. Greville', is in the Edinburgh Herbarium, and well illustrates the characters described above. Prof. Macbride considers that *Stemonitis Tubulina* Alb. & Schw. (Consp. Fung., 102) refers to this species, but the spores are described as dark brown, and Fries, who had seen the type of *S. Tubulina*, regarded it as a confluent form of *Stemonitis fusca* with the summits of the sporangia black and shining as the result of too rapid drying (Syst. Myc., iii. 157).

Hab. On dead coniferous wood.—Yorkshire, Staffordshire, Aberdeenshire, Norway, Poland, Japan, Pennsylvania, Massachusetts, Washington.

Genus 27.—**BREFELDIA** Rostafinski Versuch, 8 (1873) (O. Brefeld, a German botanist; b. 1839). Aethalium pulvinate, consisting of subcylindrical, somewhat branched and confluent sporangia, rising from a base of spongy barren tissue, which is continued among the lower portions of the sporangia in irregular folds; imperfect sporangium-walls and central columellae sometimes present. Capillitium of numerous horizontal threads, uniting at the surface of the adjacent sporangia to form many-chambered vesicles.

1. **B. maxima** Rost. Versuch, 8 (1873) (largest). Plasmodium creamy-white. Aethalium large pulvinate, 2 to 30 cm. or more across, 5 to 10 mm. thick, purplish-brown, composed of elongated branching sporangia 0·3 to 0·5 mm. diam., extending upwards from the spongy basal tissue; distinct rigid columellae often present. Capillitium consisting of numerous dark threads radiating from the inner part of each sporangium, free from the columella; each thread

expands at the surface of the sporangium into a many-chambered vesicle, which is continued into a corresponding radial thread of the adjoining sporangium ; the proximal ends of the threads are connected in clusters of three or four by a fragile membrane ; the vesicles are of firm texture, often containing a spore in several of the chambers, occasionally coalescing in fewer or greater numbers to form vertical scalariform strands. Spores purplish-brown, minutely spinulose, 9 to 12 μ diam.—Rost. Mon., 213 ; Mass. Mon., 91 ; Macbr. N. Am. Slime-Moulds, ed. 2, 154. *Dermodium inquinans* Fr. Symb. Gast., 9 (1817) ? *Reticularia maxima* Fr. Syst. Orb. Veg., i. 147 (1825). *Licea perreptans* Berk. in Gard. Chron., 1848, 451.

Pl. 136.—*d.* subdiagrammatic view of portions of four columnar sporangia from an aethalium ; each sporangium has a central columella, and is clothed on the surface with numerous vesicles, from which short capillitium threads pass into the adjacent sporangia ; at *x.* is seen a scalariform strand, formed by vertical union of a row of vesicles ; *e.* capillitium threads and vesicles ; *f.* spores (England).

The complex structure of the capillitium is difficult to follow in the lower part of an aethalium ; towards the surface the sporangia are often separated from each other by narrow intervals ; their sides are then seen to glitter with the numberless vesicles of the capillitium, the threads of which penetrate the adjacent sporangia to the distance of 0·07 to 0·1 mm., or about half the radius. The entire length of the threads, including the central vesicle, is 0·15 to 0·23 mm. The mass of spores in the central part of the sporangium is not traversed by any threads. In the lower strata the threads are sometimes attached at each extremity to folds of the membrane arising from the spongy base ; the rigid columellae, throughout the upper part at least, are free from the capillitium. The plasmodia are sometimes very large, and may wander from the place of emergence and climb adjacent plants or other objects to mature into aethalia one or two feet in length. In the field this species often shows considerable resemblance to the confluent form of a *Stemonitis*, the genus to which *Brefeldia* appears to be nearly allied.

Hab. On dead wood : not uncommon in the British Isles in autumn and winter ; widely distributed throughout Europe and the United States.

Order II.—*LAMPROSPORALES.*

Spores variously coloured, not violet-brown or purplish-grey, except in *Licea minima* and *Listerella*, q.v.

Suborder I.—*ANEMINEAE.*

Capillitium absent or not forming a system of uniform threads, except in *Alwisia*, q.v.

Family I.—Heterodermaceae.

Sporangium-wall membranous, studded with microscopic round granules (plasmodic granules), either continuous or forming a net in the upper part ; capillitium wanting ; spores 4 to 7 μ diam.

KEY TO THE GENERA OF *HETERODERMACEAE*.

Sporangia sessile, compacted or aethalioid, the wall not forming a net in the upper part. (28) LINDBLADIA

Fig. 36.—*Lindbladia effusa* Rost.

a. Aethalium. Natural size.

b. Vertical section of aethalium. Magnified 6 times.

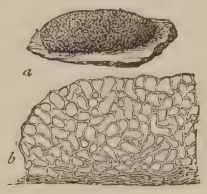


Fig. 36.

Sporangia stalked ; sporangium-wall with thickenings in the form of a delicate persistent net expanded at the nodes. (29) CRIBRARIA

Fig. 37.—*Cribraria vulgaris* Schrad.

a. Group of sporangia. Twice natural size.

b. Sporangium after dispersion of the spores. Magnified 20 times.



Fig. 37.

Sporangia stalked ; sporangium-wall with thickenings in the form of nearly parallel ribs extending from the base to the apex, connected by delicate threads. (30) DICTYDIUM

Fig. 38.—*Dictydium cancellatum* Macbr.

a. Group of sporangia. Twice natural size.

b. Sporangium after the dispersion of spores. Magnified 20 times.

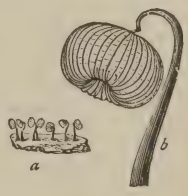


Fig. 38.

Genus 28.—**LINDBLADIA** Fries Summa Veg. Scand., 449 (1849) (M. A. Lindblad, 1821 to 1899, a Swedish botanist). Sporangia either combined to form an aethalium, or closely compacted, rarely free ; sporangium-wall membranous, studded with microscopic dark plasmodic granules.

1. **L. effusa** Rost. Mon., 223 (1875) (poured out). Plasmodium brownish-black. Sporangia cylindrical, convolute, combined to form a more or less complex effused or pulvinate aethalium, 1 to 25 cm. across, 2 to 10 mm. thick, either black

with a cortex of imperfectly developed spores, or umber-brown and the surface formed by the convex summits of the component sporangia each about 0·4 mm. diam.; hypothallus strongly developed, membranous, forming a more or less spongy tissue; sporangium-walls entire or perforated, membranous, yellow-brown, studded with dark plasmodic granules grouped in clusters or forming irregular veins. Spores ochraceous-brown, faintly warted, 4 to 6 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 204. *Licea effusa* Ehrenb. Sylv. Myc. Berol., 26 (1818). *Reticularia maxima* Corda Icon., vi. 14, t. ii, fig. 35 (1854). *Lindbladia Tubulina* Fr. Summ. Veg. Scand., 449 (1849); Lister Mycetozoa, 137. *Aethalium melaenum* Chev. in Fung. et Byss. Illustr., i. (1837), t. 32. *A. atrum* Preuss in Linnaea, xxiv. 141 (1851). *Tubulina effusa* Mass. Mon., 41 (1892).

Var. **simplex** Rex in Bot. Gaz., xvii. 202 (1892). Sporangia shortly cylindrical, closely compacted, sessile, rarely free and shortly stalked.—*Licea spermoides* Berk. & Curt. in Grev., ii. 68 (1873). *Physarum caespitosum* Peck in Rep. N. York Mus., xxvi. 75 (1874). *Perichaena caespitosa* Peck l.c., xxxi. 57 (1879). *Tubulina spermoides* Mass. Mon., 37 (1892). *T. caespitosa* Mass. l.c., 43.

Pl. 137.—*a*. vertical section of part of a pulvinate aethalium; *b*. fragment of sporangium-wall and spores; *c*. sporangia, var. *simplex*; *d*. sessile and stalked sporangia var. *simplex* approaching *Cribraria argillacea*; *e*. fragment of sporangium-wall and spores of same; *f*. spore (United States).

The sporangium-walls in the aethalioid form are usually continuous; some aethalia, however, gathered by Mr. K. Minakata in the province of Kii, Japan, have the walls widely perforated with large rounded openings as in the genus *Enteridium*. A complete series of intermediate forms connects the var. *simplex* on the one hand with typical *L. effusa* and on the other with *Cribraria argillacea*, as was first pointed out by Dr. Rex. *Licea spermoides* Berk. & Curt. is var. *simplex*, and is represented by several specimens in the Kew Collection, including the type from Alabama referred to by Rostafinski in his App. 32; he cites the name as a synonym for *Cribraria argillacea* (K. 1695), but the sporangium-wall shows no indication of a net to warrant its being placed under that species.

Hab. On dead coniferous wood and sawdust heaps: widely distributed throughout Great Britain, and North Temperate regions; recorded also from Ceylon: var. *simplex* recorded from Moldavia, Japan, and the United States.

Genus 29.—**CRIBRARIA** Persoon in Roemer Neues Mag. Bot., i. 91 (1794) (from *cribrum* a sieve). Sporangia globose or pyriform, stalked; sporangium-wall either forming a cup in the lower half or reduced to a basal disc, continued above as a net of slender threads more or less expanded and thickened at the nodes, membranous and evanescent in the meshes of the net.

KEY TO THE SPECIES OF *CRIBRARIA*.

A. Nodes of the net rarely thickened (see also 8) :—

A. Spores clay-coloured, cup imperfectly defined, sporangium-wall subpersistent above. 1. *C. argillacea*

B. Spores dull crimson, net close. 2. *C. rubiginosa*

C. Spores nut-brown or rufous—
Sporangia 0·6 mm. diam., net lax. 3. *C. rufa*
Sporangia 0·1 to 0·2 mm. diam. 4. *C. minutissima*

D. Spores brick-red ; sporangia 1 to 1·5 mm. diam. 5. *C. ferruginea*

B. Nodes of net thickened :—

A. Spores ochraceous or yellow—

a. Cup ribbed, perforated at the margin, merging into the branching nodes. 6. *C. macrocarpa*

b. Cup well-defined, nodes usually flattened, angular, branching. 7. *C. vulgaris*

c. Cup replaced by strong ribs, nodes either flattened or little developed. 8. *C. splendens*

d. Cup well-defined or absent, nodes thickened, prominent, numerous—
Nodes with free rays, and connected by five to eight slender threads. 9. *C. intricata*
Nodes rounded in outline, often without free rays, connected by four to five slender threads. 10. *C. tenella*

B. Spores dull red or brownish-pink—

a. Stalk two to four times the height of the sporangium ; plasmodic granules dark, 1 to 2 μ diam. 11. *C. piriformis*

b. Stalk four to six times the height of the sporangium—
Cup one-third the height of the sporangium, nodes polygonal. 12. *C. languescens*
Cup minute or absent, nodes rounded, prominent. 13. *C. microcarpa*

C. Spores purple-red—
Cup one-third the height of the sporangium, 0·7 mm. diam. 14. *C. purpurea*
Cup one-half of the sporangium, 0·5 mm. diam. 15. *C. elegans*

D. Spores violet-blue. 16. *C. violacea*

1. **C. argillacea** Pers. in Roemer Neues Mag. Bot., i. 91 (1794) (clayey). Plasmodium lead-coloured or purplish-olive. Total height 0·75 to 1·5 mm. Sporangia globose, crowded, shortly stalked or nearly sessile, 0·5 to 0·8 mm. diam., when immature lilac or lead-coloured, at length clay-coloured ; cup imperfectly defined ; sporangium-wall often persistent throughout, delicately membranous above, stouter towards the base where it is usually strengthened with rather few strong ribs, or reticulated all over with strongly or faintly thickened bands, which form a net with hardly expanded nodes and meshes about 0·1 mm. wide. Plasmodic granules dark, 1 μ diam. Stalk 0·1 to 0·8 mm. high, furrowed, dark brown, arising from a well-developed hypothallus. Spores ochraceous, nearly smooth, 5 to 6 μ diam.—Rost. Mon., 238 ; Mass. Mon., 65 ; Macbr. N. Am. Slime-Moulds, ed. 2, 218. *Stemonitis argillacea* Pers. in Gmel. Syst. Nat., ii. 1469 (1791). *S. sphaerocarpa* Schrank in Roem. & Ust. Mag. Bot., xii. 20 (1790) ? *Cribraria micropus* Schrad. Nov. Gen. Pl., 3 (1797). *Trichia argillacea* Poiret in Lam. Encycl., viii. 55 (1808). *Licea brunnea* Preuss in Linnaea, xxvi. 709 (1853) ?

Pl. 138.—*a*. sporangia (England) ; *b*. net of sporangium-wall and stalk ; *c*. spores and plasmodic granules ; *d*. spores.

This species varies much in the extent to which the ribs and net of the sporangium-wall are developed. In the usual form the thickened bands are dark brown, well-defined, hardly expanded at the nodes, often stouter towards the base ; but in some gatherings the thickenings are close, faint, and broad, and the wall of the sporangium is nearly uniform in texture, when it closely resembles the var. *simplex* of *Lindbladia effusa*.

Hab. On dead wood : abundant in the British Isles in summer and autumn ; widely distributed throughout all temperate regions.

2. **C. rubiginosa** Fries Syst. Myc., iii. 172 (1829) (rusty). Plasmodium purple-black. Total height 2 to 4 mm. Sporangia forming large colonies on a well-developed hypothallus, ellipsoid or subglobose, stalked, 1 to 1·7 mm. high, 1 to 1·5 mm. broad, dull crimson ; cup one-third to half the height of the sporangium, ill-defined above, thickened with numerous oblique curved or horizontal lines, or closely reticulated with thickened bands, studded with plasmodic granules 1 to 1·5 μ diam. ; net of slender red-brown rigid threads with a mesh about 0·1 mm. diam., without conspicuous expansions at the nodes. Stalk rugged, dark brown, 0·3 to 3·5 mm. long, 0·2 mm. thick. Spores rufous, minutely warted, 5 to 6 μ diam.—Meylan in Bull. Soc. Vaud., xliv. 294.

Pl. 139.—*a*. sporangia (Sweden) ; *b*. sporangium after dispersion of spores, from a mounting in Canada balsam ; *c*. part of net of sporangium-wall with margin of cup ; *d*, *e*. spores.

This handsome species is allied to *C. macrocarpa*, but differs in the ruddy colour of the spores, and in the less expanded nodes of the sporangial net. It is not uncommon in mountain woods in Moldavia, where Prof. Brandza describes colonies several centimetres across on decayed trunks of spruce

and silver fir. The sporangia are crimson when fresh and fade to brown on weathering. M. Meylan finds in the Jura Mountains a form with stalks two and even three millimetres long which he has published as var. *longipes* (l.c.).

Hab. On dead coniferous wood, in autumn.—Sweden, Switzerland, Moldavia.

3. **C. rufa** Rost. Mon., 232 (1875) (red). Plasmodium milk-white. Total height 1·5 to 2 mm. Sporangia scattered, stalked, subglobose or turbinate, erect, 0·6 to 0·7 mm. diam., bright orange-red; cup one-third the height of the sporangium, with a regularly toothed margin, more or less ribbed, the thicker ribs continued into the wide-meshed net; the plasmodic granules of the sporangium-wall hardly 1 μ diam.; nodes of the net scarcely expanded, or narrow, triangular and flattened, connected by three or four firm threads. Stalk cylindrical, the length of the sporangium or more, 0·2 mm. thick, longitudinally rugose, black. Spores pale yellowish-red, minutely warted, 5 to 8 μ diam.—Mass. Mon., 63; Macbr. N. Am. Slime-Moulds, ed. 2, 220. *Stemonitis rufa* Roth Fl. Germ., i. 548 (1788). *Cribraria rufescens* Pers. in Roemer N. Mag. Bot., i. 91 (1794); Lister Mycetozoa, 140. *C. intermedia* Schrad. Nov. Gen. Pl., 4 (1797). *C. fulva* Schrad. l.c., 5. *Trichia rufescens* Poiret in Lam. Encycl., viii. 55 (1808).

Pl. 140.—*a.* sporangia (Scotland); *b.* net and cup of sporangium-wall; *c.* spore and plasmodic-granules.

This well-marked species is remarkably constant in its characters; it appears to be most nearly allied to *C. minutissima*, from which it differs in its much larger proportions.

Hab. On coniferous wood or on dead trunks of *Castanea*.—Not uncommon in the British Isles and widely distributed throughout Europe; recorded also from Japan, Prince Edward's Isle, and the States of Oregon and Washington.

4. **C. minutissima** Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 260 (1832) (very minute). Plasmodium blackish-blue. Total height 0·5 to 0·7 mm. Sporangia stalked, gregarious, globose, erect or inclined, 0·1 to 0·2 mm. diam., nut-brown; cup either about half the height of the sporangium, or entirely wanting, pale nut-brown, nearly even at the margin, faintly striate longitudinally with lines of plasmodic granules 1 μ diam.; nodes of the net not expanded, or narrow and flattened, connected by three to five slender threads. Stalk filiform, one and a half to four times the height of the sporangium, brown. Spores ochraceous, minutely spinulose, 5 to 6·5 μ.—Rost. Mon., App. 31; Macbr. N. Am. Slime-Moulds, ed. 2, 220. *Cribraria minima* Berk. & Curt. in Grev., ii. 67 (1873); Mass. Mon., 59. *C. microscopica* Berk. & Curt. l.c.; Rost. l.c.; Mass. Mon., 62.

Pl. 140.—*d.* to *g.* sporangia after dispersion of spores; *h.* spore and plasmodic granules (United States).

In the large gatherings obtained by Dr. Rex of this minute species, there is great variety in the size of the cup and in the extent to which the nodes of the net are enlarged. Nothing now remains in this country of the type specimen of *C. microscopica* Berk. & Curt., but from Berkeley's description and figure it appears to be a form of the present species with the nodes of the net rather widely expanded. The type of *C. minima* Berk., from South Carolina (B.M. 671) is also the present species; the nodes of the net are either triangular or unexpanded, and the cup is deep.

Hab. On dead coniferous wood.—France, Jura Mountains, Ceylon, Malaya, Pennsylvania, South Carolina, Missouri, Colorado, Iowa, South Dakota.

5. **C. ferruginea** Meylan in Ann. Cons. Bot. Genève, 1913, 319 (rust-coloured). Plasmodium? Sporangia crowded on a membranous hypothallus, stalked, sub-globose, narrowing into the stalk, brick- or orange-red, 1 to 1·5 mm. diam.; sporangium-wall forming a small ill-defined cup, marked with narrow dark ribs which merge above into the net, the nodes of which are hardly expanded; the meshes of the net average 0·1 mm. across and are bounded by slender red-brown threads about 2 μ diam. Plasmodic granules 1 μ diam. Spores 5 to 7 μ, minutely warted, bright brick-red or orange-red in mass, pale red by transmitted light.

Pl. 219.—*a.* group of sporangia; *b.* sporangium after spore dispersal; *c.* from lower part of sporangial net; *d.* spore and thread of sporangial net.

This beautiful species resembles *C. macrocarpa* in having shortly turbinate sporangia and a strongly ribbed cup, but differs in the nodes of the net being scarcely developed and in the bright brick-red colour of the spores. It has been recorded hitherto from Switzerland only.

Hab. On dead coniferous wood.—Jura Mountains, Goldau (Canton Schwyz), Wengen (Canton Bern), Iserable (Canton Vailais).

6. **C. macrocarpa** Schrad. Nov. Gen. Pl., 8 (1797) (μακρός large, καρπός fruit). Plasmodium slate-coloured. Total height 2 mm. Sporangia stalked, gregarious or scattered, globose or turbinate, 0·6 to 1 mm. diam., nut-brown; cup about one-third of the sporangium, orange-brown, with numerous dark longitudinal ribs, perforated above, irregularly and deeply toothed at the margin and merging into the branching nodes of the net; nodes flattened, elongated, confluent and irregular in the lower part, branching and polygonal with the angles continued into the connecting threads above; the nodes and ribs of the cup studded with dark plasmodic granules 1 to 2 μ diam. Stalk 0·8 to 1 mm. high, 0·1 mm. thick, furrowed, dark brown. Spores ochraceous, nearly smooth, 4 to 6 μ diam.—Rost. Mon., 238; Mass. Mon., 56; Macbr. N. Am. Slime-Moulds, ed. 2, 219. *C. tatrica* Racib. in Hedw., xxiv. 170 (1885); *Trichia macrocarpa* Poiret in Lam. Encycl. viii. 55 (1808). *Heterodictyon Bieniaszii* Racib. l.c., xxviii. 121 (1889).

Pl. 141.—*a.* sporangia after dispersion of spores; *b.* part of net and cup of sporangium (Freiburg, Germany, specimen named by Rostafinski); *c.* net and cup of sporangium (Black Forest, Germany); *d.* spore, and plasmodic granules.

Specimens from America from low elevations have usually more numerous and slender connecting threads and more prominent nodes in the upper part of the net; they approach forms of *C. intricata*, while the European type more nearly resembles stout forms of *C. vulgaris*; a gathering made by Dr. Rex at an elevation of 6,200 feet on Roan Mount, North Carolina, exactly corresponds with the European form.

Hab. On dead coniferous wood.—Forfarshire, Nairnshire, Sweden, Norway, Germany, Switzerland, Moldavia, South Chili, North and South Carolina, Pennsylvania, New York, Oregon, and Ontario.

7. **C. vulgaris** Schrad. Nov. Gen. Pl., 5 (1797) (common). Plasmodium usually slate-grey. Total height 1 to 2 mm. Sporangia gregarious, stalked, globose, erect or nodding, 0·4 to 0·7 mm. diam., nut-brown; cup one-third the height of the sporangium, irregularly and deeply toothed at the margin, studded with round plasmodic granules 0·5 to 1 μ diam. arranged in close lines radiating from the base of the sporangium; nodes of the net flattened, broad, branching and angular, or narrow, the angles continued into the slender connecting threads, often with a few free rays. Stalk subulate, dark brown, two to four times the height of the sporangium. Spores ochraceous, minutely warted, 5 to 6 μ diam.—Rost. Mon., 234; Mass. Mon., 61. Meylan in Ann. Cons. Bot. Genève, 1913, 318. *C. variabilis* Ficin. & Schub. Fl. Dresden, ii. 296 (1823) ? *C. intermedia* Berk. in Sm. Engl. Fl., v., ii. 318 (1836). *Sphaerocarpus semitrichioides* Bull. Champ., 125 pl. 387, fig. 1 (1791) ?

Var. **aurantiaca** Pers. Syn. Fung., 194 (1801) (orange-coloured). Plasmodium green: nodes of the net usually dark-brown, convex, crowded with plasmodic-granules; spores yellow.—*C. aurantiaca* Schrad. l.c., 5, Rost. l.c., 233; Macbr. N. Am. Slime-Moulds, ed. 2, 221.

Pl. 142.—*a*, *b*. sporangia; *c*. sporangium of var. *aurantiaca*; *d*, *e*. part of net and margin of cup of '*a*' and of '*b*' respectively; *f*. spores and plasmodic granules; *g*. spores.

Rostafinski's specimens of *C. vulgaris* in Strasb. Herb., differ in no respect from those he has named *C. aurantiaca*. In describing three forms of *C. vulgaris*, '*α genuina*, *β aurantioides*, *γ delicatula*', he recognizes the great variability to which the species is subject, and points out how closely his form *β* approaches *C. aurantiaca*. Gatherings at Lyme Regis from the same fir log in consecutive years, show variations in the cup, net, and colour, which illustrate the characters given in Rostafinski's description and figures of both *C. aurantiaca* and *C. vulgaris*. Usually, however, a short-stalked form with ochraceous spores, maturing from slate-grey plasmodium, can be distinguished from a taller form maturing from bright green plasmodium, and with spores golden-yellow when fresh; this colour fades to an ochraceous shade when specimens have been kept for some months. Intermediate forms occur connecting *C. aurantiaca* with a group of allied species; a large form having a strongly ribbed cup approaches *C. macrocarpa*; when the nodes and cup have dense deposits of dark plasmodic granules, the form approaches *C. piriformis*; when the cup is shallow and is connected with the net by ribs, it may resemble *C. splendens*, while the forms with a close and regular net approach *C. tenella* or *C. intricata*.

8. **C. splendens** Pers. Syn. Fung., 191 (1801) (shining or beautiful). Plasmodium lead-colour. Total height 1·5 mm. Sporangia globose, stalked, erect or inclined, scattered, 0·3 mm. diam., nut-brown ; sporangium-wall consisting in the lower half of nine or more free ribs with little trace of a persistent cup, continued into a loose net with small triangular or polygonal nodes, or the nodes may be scarcely developed ; plasmodic granules minute, inconspicuous. Stalk slender, brown, four or five times the length of the sporangium. Spores pale ochre, almost smooth, 5 μ diam.—Rost. Mon., 236 ; Mass. Mon., 64 ; Macbr. N. Am. Slime-Moulds, ed. 2, 221. *Dictydium splendens* Schrad. Nov. Gen. Pl., 14 (1797). *Trichia splendens* Poiret in Lam. Encycl., viii. 55 (1808).

Pl. 141.—*e*. sporangium after dispersion of spores (Germany ; specimen named by Rostafinski) ; *f*. part of net of sporangium ; *g*. sporangium (Switzerland) ; *h*. spores and plasmodic granules.

C. splendens differs from *C. aurantiaca* in having strong ribs taking the place of a cup. The persistent shining wall between the net mentioned by Rostafinski has almost disappeared in the specimen named by him in the Strasburg Herbarium, but as this membrane is occasionally persistent in nearly every species of *Cribraria*, the character is not important. *C. splendens* appears to be connected by intermediate forms with *C. aurantiaca*, *C. intricata*, and *C. tenella*. M. Meylan finds a beautiful form in the Jura Mountains with the nodes little or not at all expanded ; it somewhat resembles *C. minutissima*, from which it differs in the larger size and in the strong ribs at the base of the sporangium.

Hab. On dead coniferous wood.—Sweden, Germany, Switzerland, Moldavia, Singapore, Japan, Ontario, the States of New York, Pennsylvania, Iowa and Washington, and South Chili.

9. **C. intricata** Schrad. Nov. Gen. Pl., 7 (1797) (complex). Plasmodium lead colour or brownish-black. Total height 1·5 to 3 mm. Sporangia gregarious, often forming large colonies, stalked, globose, nodding or erect, 0·5 to 0·7 mm. diam., ochraceous-brown ; cup one-third the height of the sporangium, yellow-brown, studded with brown plasmodic granules 0·5 to 2 μ diam. arranged in close lines radiating from the base of the sporangium ; margin toothed ; net close, regular ; nodes numerous, dark brown, thickened, prominent, polygonal, often branching, connected by five to eight very slender threads, and with many free rays. Stalk subulate, two to four times the height of the sporangium, dark brown. Spores ochraceous, nearly smooth or faintly warted, 5 to 6 μ diam.—Rost. Mon., 237 ; Mass. Mon., 59 ; Macbr. N. Am. Slime-Moulds, ed. 2, 223. *C. dictydioides* Macbr. l.c., 222 (1922). *Trichia intricata* Poiret in Lam. Encycl., viii. 56 (1808).

Var. **dictydioides** Lister Mycetozoa, 144 (1894) (*Dictydium*). Plasmodium dark green. Cup almost or quite obsolete ; the nodes in the lower part of the net elongated and confluent, forming ribs converging to the apex of the stalk.—*Cribraria dictydioides* Cooke & Balf. (in Rav. Fung. Amer. Exs., no. 475)

ex Mass. Mon., 65 (1892); Macbr. N. Am. Slime-Moulds, ed. 2, 222.

Pl. 143.—*a*, *b*. sporangia after dispersion of spores; *c*. part of net and cup of sporangium (Borneo); *d*. sporangium, var. *dictydioides* (South Carolina; type of *C. dictydioides* Cooke & Balf.); *e*. spore and plasmodic granules.

This species is abundant in the United States and in the tropics; it is less frequent in Europe, and the typical form has hardly been met with except in hot-houses in the British Isles; forms intermediate between *C. intricata* and *C. aurantiaca* are, however, not uncommon in England. The specimens in the Kew Herbarium marked *Cribraria Balfourii* de Bary, K. 963, on Sphagnum from the hot-houses of the Royal Botanic Gardens, Edinburgh, are small developments of the var. *dictydioides*. A nearly similar form was obtained in orchid-houses at Lamberhurst, Kent, and at Clevedon, Somerset. The last-named specimen is quoted by Massee as *C. microcarpa* (l.c., 64).

Hab. On dead wood.—Yorkshire, Sweden, France, Italy, Roumania, Cape Province, New Zealand; abundant in Japan, in the United States and in the tropics: var. *dictydioides* is also abundant in the United States and the tropics, and has been recorded from Sweden and Moldavia.

10. **C. tenella** Schrad. Nov. Gen. Pl., 6 (1797) (delicate). Plasmodium brown-black. Sporangia closely resembling *C. intricata* in size, shape, colour, and spores; cup one-third the height of the sporangium, or more or less obsolete; net close, regular; nodes numerous, dark brown, rounded, rarely elongated, prominent, with few or no free rays, connected by three to six very slender threads.—Rost. Mon., 235; Mass. Mon., 58; Macbr. N. Am. Slime-Moulds, ed. 2, 225. *C. elata* Mass. l.c., 61 (1892).

Var. **concinna** G. Lister (neat). Sporangia 0·15 to 0·3 mm. diam.; cup small or none; net close with rounded nodes.—*C. microcarpa* Macbr. l.c., 226 (1922) ?

Pl. 143.—*f*. sporangium after dispersion of spores; *g*. part of net of sporangium (Ceylon: named by Rostafinski); *h*. part of net and margin of cup (Philadelphia); *i*. spore and plasmodic granules.

Both *C. tenella* and *C. intricata* are abundant in the United States, where frequent intermediate forms occur. The specimen figured, from Ceylon (K. 1684), referred to by Rostafinski as *C. tenella* (Mon., App. 31), has a small cup, rounded or elongated prominent nodes, with no free rays. The var. *concinna* is a small neat form somewhat resembling *C. microcarpa*, but differing in the yellow-brown colour of the sporangia, and the smaller plasmodic granules hardly 1 μ diam.

Hab. On dead wood.—Surrey, Norfolk, Yorkshire, Salop, County Wicklow; Sweden, Switzerland, Poland, Moldavia. Abundant in Japan and in the United States; not uncommon in the tropics; recorded also from the Cape Province: var. *concinna* from Dominica, Florida, Pennsylvania, Colorado, and Iowa.

11. **C. piriformis** Schrad. Nov. Gen. Pl., 4 (1797) (*pirum* pear, *forma* shape). Plasmodium pale slate colour? Total height 1 to 1·7 mm. Sporangia gregarious, turbinate or globose, stalked, 0·4 to 0·9 mm. diam.; spore mass pinkish- or lilac-brown, becoming yellowish-brown with age; cup

about one-third the height of the sporangium, brownish-pink or brownish-yellow, perforated and irregularly toothed at the margin, or equally toothed, studded with large round purple-brown plasmodic granules 2 to 2·5 μ diam., arranged in broad lines radiating from the base or evenly distributed ; nodes of the net varying in shape and size, flat, polygonal, triangular or elongated, often branching, some usually not expanded, charged with dark round plasmodic granules and connected by firm yellowish or brown threads ; in some developments the net is lax and incomplete and the broader threads have many free hooked branchlets. Stalk stout, 0·5 to 2·5 mm. high, dark purple-brown. Spores brownish-pink, becoming ochraceous with age, almost smooth, 5 to 6 μ diam.—Rost. Mon., 237 ; Mass. Mon., 55 ; Macbr. N. Am. Slime-Moulds, ed. 2, 224.

Var. **notabilis** Rex ex Lister Mycetozoa, ed. 2, 182 (1911). Sporangia globose ; nodes convex and prominent, rounded or irregular with slender connecting threads ; stalks slender.

Pl. 144.—*a*. sporangia after dispersion of spores ; *b*. part of net and cup of sporangium (Shrewsbury, England) ; *c*. sporangium from mounting in Canada balsam (Germany, specimen named by Rostafinski) ; *d*. part of net and cup of same ; *e*. sporangia, var. *notabilis* ; *f*, *g*. part of net and cup of same ; *h*. spore and plasmodic granules (United States) ; *i*. spores.

The var. *notabilis* has been found in abundance on old sawdust heaps in Sussex and Surrey. It differs from the typical form in the sporangia being always globose, in the delicate threads of the net, and in the nodes, which are usually prominent and convex. The plasmodic granules vary in abundance in different gatherings. M. Meylan has published a var. *fusco-purpurea* (Ann. Cons. J. Bot. Genève, 1913, 319), characterized by the nodes of the net not being expanded,—possibly not a constant form.

Hab. On dead coniferous wood.—Somerset, Hampshire, N. Wales, Perthshire, Inverness-shire, Aberdeenshire ; France, Sweden, Germany, Switzerland, Roumania, Portugal, Japan, Connecticut, New Hampshire : var. *notabilis*, Surrey, Sussex, Switzerland, Portugal; widely distributed in the United States.

12. **C. languescens** Rex in Proc. Acad. Nat. Sci. Phil., 1891, 394 (becoming feeble, drooping). Plasmodium red. Total height 2·5 to 3 mm. Sporangia scattered, stalked, globose, often drooping, 0·25 to 0·35 mm. diam., dull red ; cup about one-third the height of the sporangium, red-brown, shining, studded with purple-brown plasmodic granules 0·3 to 1·5 μ diam., arranged in close lines radiating from the apex of the stalk ; margin toothed ; nodes of the net purplish-brown, thickened, rather prominent, charged with dark granules, polygonal, with few free rays and with slender connecting threads ; meshes of the net triangular. Stalk long and slender, subulate, often sinuous or wavy, dark red-brown. Spores dull red in mass, pale red by transmitted light, almost smooth, 5 to 6·5 μ diam.— Macbr. N. Am. Slime-Moulds, ed. 2, 229. *C. cuprea* Morg. in Journ. Cinc. Soc. Nat. Hist., xv. 142 (1893) ; Macbr. l.c., 229.

Pl. 145.—*a*. sporangia after dispersion of spores ; *b*. part of net and margin of cup of sporangium ; *c*. spore and plasmodic granules (United States).

This slender species somewhat resembles *C. microcarpa*, but differs in the well-developed cup, and in the paler smaller plasmodic granules. *C. cuprea* Morg. differs from typical *C. languescens* only in the spores in mass being copper coloured and paler, a character which can hardly be considered of much importance.

Hab. On dead wood.—Sweden, Austria, Switzerland (in an orchid-house), South Nigeria, Ceylon, Japan, the West Indies ; rare in the United States, recorded from South Carolina, Ohio, New York ; also in Ontario.

13. **C. microcarpa** Pers. Syn. Fung., 190 (1801) (μικρός small, καρπός fruit). Plasmodium greenish or purple-black. Total height 0·7 to 2 mm. Sporangia gregarious, globose, stalked, erect or nodding, 0·1 to 0·3 mm. diam., purplish-red ; cup rudimentary or wanting ; net close, regular ; nodes of the net subglobose, prominent, about 10 μ diam., densely charged with usually very dark purple-brown plasmodic granules 1 to 2 μ diam., connected by five or six slender pink threads. Stalks slender, four to ten times the height of the sporangium, purple-brown. Spores in mass pale red, minutely spinulose, 5 to 6 μ diam.—Rost. Mon., 235 ; Mass. Mon., 63 ; Petch in Ann. Perad., iv. 356. *C. capillaris* Fr. Stirp. Femsj., 84 (1825) ? *Trichia microcarpa* Poiret in Lam. Encycl., viii. 54 (1808). *Dictydium microcarpum* Schrad. Nov. Gen. Pl., 13 (1797).

Pl. 145.—*d*, *e*. sporangia after dispersion of spores (*d*. Germany, specimen named by Rostafinski, *e*. United States) ; *f*. part of net with cup of sporangium (Germany) ; *g*. the same (United States) ; *h*. spore and plasmodic granules.

Hab. On dead wood.—France, Germany, Switzerland, Austria, Bohemia, Moldavia, Portugal, Ceylon, Malaya, Japan, New Hampshire, Connecticut, Pennsylvania.

14. **C. purpurea** Schrad. Nov. Gen. Pl., 8 (1797) (purple). Plasmodium staining the wood from which it emerges purple-red ; ' scarlet before formation of fruit ' (Macbride). Total height 2 to 2·5 mm. Sporangia crowded or gregarious, globose, erect or inclined, 1 mm. diam., purple or purple-red ; cup one-third of the sporangium, with a deeply toothed margin ; net of slender threads with mesh of varying size, most or a few of the nodes expanded, flat, membranous, angular or branched ; plasmodic granules purple, 2 to 2·5 μ diam., thickly distributed over the cup, often arranged in oblique lines. Stalk purple-black, furrowed, 1·5 mm. long, 0·1 mm. thick. Spores purplish, minutely warted, 5 to 6 μ diam.—Rost. Mon., 233 ; Mass. Mon., 57 ; Macbr. N. Am. Slime-Moulds, ed. 2, 228.

Pl. 146.—*a*. sporangium after dispersion of spores ; *b*. part of net ; *c*. spore and plasmodic granules.

Prof. Brandza describes this species as occurring on almost every decaying coniferous log in the mountain forests of Moldavia ; he finds that it develops late in the year, usually in December, when some of the *Abies* logs look as if clothed with a robe of cardinal-violet, from the abundance of the sporangia. Weathered specimens change from purple to purple-red.

Hab. On dead coniferous wood.—Norway, Sweden, France, Germany, Switzerland, Austria, Bohemia, Moldavia, Japan, Ontario; widely distributed in the United States.

15. **C. elegans** Berk. & Curt. in Grev., ii. 67 (1873). Plasmodium ? Total height 0·7 to 1·3 mm. Sporangia gregarious, globose, stalked, erect or inclined, 0·3 to 0·4 mm. diam., red-purple; cup about half the height of the sporangium, with the margin deeply toothed and perforated; net of very slender threads connecting numerous branching flat expanded nodes; both cup and nodes thickly studded with round purple plasmodic granules 2 to 2·5 μ diam. Stalk subulate, nearly smooth, 0·6 to 1 mm. long, purple-black. Spores pale violet, almost smooth, 4 to 6 μ diam.—Rost. Mon., App. 31; Mass. Mon., 55; Macbr. N. Am. Slime-Moulds, ed. 2, 228.

Pl. 146.—*d.* sporangia after dispersion of spores; *e.* part of net and margin of cup; *f.* spore and plasmodic granules (United States).

This species closely resembles a small form of *C. purpurea*; hitherto it has been obtained only from the United States, where, Prof. Macbride writes, it is much the commoner of the two species.

Hab. On dead coniferous wood.—The United States.

16. **C. violacea** Rex in Proc. Acad. Nat. Sci. Phil., 1891, 393. Plasmodium deep violet-black. Total height 0·5 to 1 mm. Sporangia gregarious, globose or ellipsoid, stalked, erect or slightly nodding, about 0·2 mm. diam., dark violet with a metallic sheen; cup varying from one-third to two-thirds the height of the sporangium or more, membranous, violet-blue, the margin scalloped with few short teeth; net of slender threads connected with broadly expanded, flat, angular nodes; 'exceptionally the apical portion is nearly entire, being simply perforated with three or four oval or rounded openings' (Rex); the cup and nodes are studded with purple plasmodic granules 0·5 to 1 μ diam. Stalk slender, subulate, violet-black. Spores lilac, minutely and closely warted, 6 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 227.

Pl. 146.—*g.* sporangium after dispersion of spores (England); *h.* part of net and margin of cup of same; *i.* sporangia (United States); *k.* part of net and cup of same; spore and plasmodic granules.

This minute species differs from *C. elegans* in the longer stalks, the smaller sporangia of a blue-, not red-purple colour, and in the larger spores. It appears in varied habitats, on dead or living bark, and on pig dung, where Prof. Thaxter found it in Florida.

Hab. On wood of beech, poplar, &c.—Devon, Worcestershire, Buckinghamshire, Yorkshire, Aberdeenshire, Switzerland, Germany, Austria, Roumania, the Cameroons, Ceylon, Malaya, Japan, West Indies, Florida, Pennsylvania, Illinois, Iowa, Colorado.

Genus 30.—**DICTYDIUM** Schrader Nov. Gen. Pl., 11 (1797) (diminutive of δίκτυον net). Sporangia globose, stalked; sporangium-wall formed of numerous ribs extending from the

base nearly to the apex, connected by slender transverse threads, the intervening wall evanescent or persistent as a shallow cup.

1. **D. cancellatum** Macbr. N. Am. Slime-Moulds, 172 (1899) (latticed). Plasmodium purple-black. Total height 1 to 2 mm. Sporangia gregarious, subglobose, nodding, 0·5 to 0·7 mm. diam., dark red-brown; sporangium-wall forming a net with nearly square meshes, composed of numerous (40 to 50) rigid longitudinal ribs, 5 μ thick, connected by slender transverse threads, and often breaking up into an irregular net at the apex; basal cup scarcely developed. Stalk subulate, bent or twisted at the slender apex, rich purple-brown or red, one to three times the height of the sporangium. Spores pale red, minutely warted, 4 to 7 μ diam., usually with two to four dark plasmodic granules on the spore wall.—*Mucor cancellatus* Batsch Elench. Fung., ii. 135, fig. 232 *a*, *b*, *c* (1789). *Stemonitis cancellata* Gmel. Syst. Nat., 1468 (1791). *Cribraria cernua* Pers. Obs. Myc., i. 91 (1796). *C.* (*Dictydium*) *trichioides* Chev. Fl. Par., 327 (1826–7). *Dictydium umbilicatum* Schrad. Nov. Gen. Pl., 11 (1797); Lister Mycetozoa, 148. *D. cernuum* Nees Syst. Pilze, 120, fig. 117 (1816); Rost. Mon., 229; Mass. Mon., 67. *D. longipes* Morgan in Journ. Cinc. Soc. Nat. Hist., xv. 143 (1893). *Trichia cernua* Poiret in Lam. Encycl., viii. 54 (1808). *T. coccinea* Poiret l.c., 55 ?

Var. **purpureum** Macbr. l.c., 173. Sporangia, stalk and spores purple; cup more or less developed; Meylan in Bull. Soc. Bot. Genève, sér. 2, ii. 265. *Cribraria exilis* Macbr. in Bull. Nat. Hist. Iowa, ii. 378 (1893).

Var. **fuscum** Lister in Journ. Bot., xxxvi. 120 (1898) (dark brown). Sporangia nodding, smaller and browner than in the type, with a well-defined cup from the margin of which the numerous ribs arise.

Var. **alpinum** Lister Mycetozoa, ed. 2, 185 (1911). Sporangia globose, erect, brown, with or without an irregular cup; ribs from twenty to thirty, branching in the upper third of the sporangium to form an irregular net; stalk not narrowed at the apex, often rugged.—*Dictydium anomalum* Meylan in Bull. Soc. Vaud., xliv. 295 (1908). *Heterodictyon mirabile* Rost. Mon., 231 (1875). *Cribraria mirabilis* Mass. Mon., 60 (1892).

Forma **anomalum** Jahn in Ber. Deutsch. Bot. Ges., xix. 99 (1901) (ἀ not, ὁμαλός ordinary). Ribs branching and anastomosing to form a *Cribraria*-like net.—*D. ambiguum* Schrad. l.c., 13. *D. venosum* Schrad. l.c., 14 ? *Cribraria venosa* Pers. Syn. Fung., 191 (1801) ?

Pl. 147.—*a*. to *d*. sporangia of various forms after the dispersion of the spores; *a*. typical form; *b*. var. *fuscum*; *c*. form with irregular net found with sporangia of usual type (England); *d*. erect sporangium (United States); *e*. spores, three of them show plasmodic granules adhering; *f*, *g*. sporangia of var. *alpinum* (type of *Hetero-*

dictyon mirabile Rost., from Freiburg); *h.* spores of same with plasmodic granules adhering.

The ribs of the sporangium-wall become inflexed at the summit, and tend to break up the ball of mature spores; they consist of two layers, the outer smooth and shining, the inner studded with purple plasmodic granules 1 μ diam.; in the typical form they are usually free to the base of the sporangium, but are sometimes connected by a small basal disc. In large developments of this species at Lyme Regis, amongst typical sporangia an irregular form often occurs with the ribs branching and anastomosing from the base or dividing in the upper half into a *Cribraria*-like network (see pl. 147 *c.*). This form is the var. *anomalum* of Dr. Jahn; it is apparently due merely to unfavourable conditions of development, and constitutes a form rather than a true variety.* The var. *fuscum*, with its well-defined cup, is widely distributed but is too inconstant to be regarded as a distinct species. The var. *alpinum* has been obtained usually at high altitudes; Dr. Sturgis has gathered it on Cheyenne Mountain, Colorado, and M. Meylan finds it abundant in the Jura Mountains at an elevation of 1,000 to 1,450 m. in the autumn months; the typical form he obtains earlier in the year, from June to August, below 1,300 m. alt. The type of *Heterodictyon mirabile* Rost., from the Höllensteig gorge in the Black Forest, is this variety; the sporangia show irregular basal cups, and the ribs are in many parts expanded and form a loose imperfect net with broad and angular nodes; in other parts the ribs are connected by the usual delicate transverse threads, and, though fewer in number and coarser than in the type, are essentially of the same character.

Hab. On dead wood: frequent in the British Isles in summer; widely distributed in temperate and tropical regions: var. *purpurea* recorded from Switzerland and Nicaragua: var. *fuscum* is widely distributed in the British Isles and throughout Europe, and has been recorded from South Nigeria, Japan, and Eastern Canada: var. *alpinum* is abundant in alpine woods in Switzerland and has been recorded also from Colorado.

Family II.—Liceaceae.

Sporangia scattered, sessile or stalked; sporangium-wall cartilaginous, rarely membranous; capillitium and columella wanting.

KEY TO THE GENERA OF *LICEACEAE*.

Sporangia sessile, subglobose or forming plasmodiocarps, opening irregularly or by lobes. (31) Licea

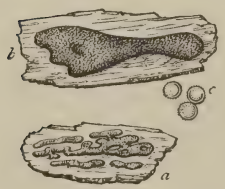


Fig. 39.

Fig. 39.—*Licea flexuosa* Pers.

a. Group of plasmodiocarps. Twice natural size.
b. Plasmodiocarp. Magnified 6 times.
c. Spores. Magnified 200 times.

* A full account of the development of this species and some of the variation to which it is subject is given by Dr. Jahn l.c., 97–115 (1901).

Sporangia sessile, opening by a membranous lid.

(32) HYMENOBOLINA



Fig. 40.—*Hymenobolina parasitica* Zukal.

a. Group of sporangia. Magnified 40 times.

b. Two spores; fragment of membranous lid and of thickened lower walls. Magnified 270 times.

Fig. 40.

Sporangia stalked, opening by a membranous lid.

(33) ORCADELLA

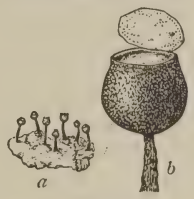


Fig. 41.—*Orcadella operculata* Wingate.

a. Group of sporangia. Magnified 8 times.

b. Sporangium with open lid. Magnified 80 times.

Fig. 41.

Genus 31.—**LICEA** Schrader Nov. Gen. Pl., 16 (1797) (derivation unknown). Sporangia sessile, subglobose, hemispherical, or forming plasmodiocarps; sporangium-wall cartilaginous or membranous; spores olive-brown or brownish-yellow, lilac-brown or nearly colourless.

KEY TO SPECIES OF *LICEA*.

A. Sporangium-wall cartilaginous :—

Sporangia hemispherical, dehiscing in lobes; spores brown, 9 to 11 μ. 1. *L. minima*

Sporangia subglobose or bolster-shaped, dehiscing in lobes; spores almost colourless, 8 to 10 μ. 2. *L. castanea*

Sporangia pulvinate, dehiscing in lobes; spores 16 to 20 μ. 3. *L. pusilla*

Plasmodiocarps elongate, 2 to 8 mm. long, dehiscing irregularly. 4. *L. flexuosa*

B. Sporangium-wall membranous :—

Plasmodiocarps about 0·2 mm. long, 0·1 mm. wide, dehiscing by a longitudinal fissure. 5. *L. biforis*

Sporangia subglobose or ovoid, olive-yellow. 6. *L. tenera*

1. **L. minima** Fr. Syst. Myc., iii. 199 (1829) (smallest). Plasmodium drab, slate-colour, watery-grey or pale yellow. Sporangia scattered, subglobose, or hemispherical, depressed, angular with prominent shining lines of dehiscence, 0·2 to 0·5 mm. diam., chestnut-brown or nearly black, dehiscing by three or four lobes; sporangium-wall cartilaginous, dark brown, opaque with granular deposits, except the margins of the lobes which are usually dotted on the inner side with minute peg-like warts 1 to 2 μ diam. Spores olivaceous-brown or lilac-brown, spinulose, 9 to 12 μ diam., the wall thinner on one side.—Macbr. N. Am. Slime-Moulds, ed. 2, 201; Torrend Fl. Myx., 66. *Tubulina minima* Mass. Mon., 36 (1892). *Kleistobolus pusillus* Lippert in Verh. Zool.-Bot. Gesell. Wien, xliv. 70, t. iii (1894).

Pl. 148.—*d.* sporangia (United States); *e.* spores and fragment of sporangium-wall showing the plasmodic granules on the margin of a lobe; *f.* spore.

This minute species may be easily overlooked; it often forms large colonies, fresh sporangia appearing from day to day among those already formed. It is closely allied to *L. pusilla*, from which it differs in the entire lobes of the sporangium and the smaller rougher spores. Glycerine preparations of the type of *Kleistobolus pusillus* Lippert, kindly lent by Prof. v. Höhnel, show this to be a nearly typical example of the present species. The rudimentary capillitium-threads described by Lippert are fungus hyphae traversing the substratum on which the sporangia are seated; the spores are faintly warted and measure 11 to 13 μ, not 7 to 9 μ, as stated by Lippert.

Hab. On dead coniferous wood.—Surrey, Bedfordshire, Yorkshire, Aberdeenshire, County Down; widely distributed throughout Europe and the United States.

2. **L. castanea** G. Lister in Journ. Bot., xlix. 61 (1911) (chestnut). Plasmodium ? Sporangia scattered, sessile, subglobose, or forming bolster-shaped plasmodiocarps, 0·2 to 0·9 mm. long, 0·2 to 0·4 mm. broad, chestnut or pale brown, smooth or wrinkled; sporangium-wall somewhat cartilaginous, nearly colourless or pale brown, overlaid by a more or less continuous layer of brown granular refuse-matter, dehiscing along definite lines to form plates or lobes whose margins are often marked with a row of minute warts 1 μ diam. Spores in mass olive-yellow, when magnified almost colourless, smooth, 8 to 10 μ diam., their walls rather thinner on one side.

Pl. 219.—*e.* group of sporangia; *f.* part of four lobes of sporangium-wall, and spores; *g.* spore.

This inconspicuous species was discovered in November 1910 by the Rev. W. Cran at Lesmoir, Aberdeenshire, on moss and living bark of *Pyrus Aucuparia* and has been gathered by him since a number of times in various parts of the county. It has been found also by M. Ch. Meylan at an altitude of nearly 3,000 feet in the Jura Mountains. In size it resembles *L. minima*, but it is distinguished by the paler sporangia, usually areolated with prominent lines of dehiscence, and by the smooth, pale spores.

Hab. On moss and bark.—Aberdeenshire and Jura Mountains.

3. **L. pusilla** Schrad. Nov. Gen. Pl., 19 (1797) (small).

Plasmodium watery-drab, or dull yellowish. Sporangia scattered, hemispherical or pulvinate, 0·6 to 1 mm. diam., dark purple-brown, glossy on the inner side, dehiscing in irregular lobes; sporangium-wall cartilaginous, chestnut-brown, the margins of the lobes usually crenate and undulate, dotted with prominent warts 1 to 2 μ diam. Spores olive-brown, 13 to 20 μ diam., closely and minutely warted, the wall thinner on one side.—Macbr. N. Am. Slime-Moulds, ed. 2, 202. *Trichia pusilla* Poiret in Lam. Encycl., viii. 131 (1808). *Physarum Licea* Fr. Syst. Myc., iii. 143 (1829). *Protoderma pusilla* Rost. Mon., 90 (1875). *Protodermium pusillum* Berl. in Sacc. Syll., vii. 328 (1888); Mass. Mon., 43.

Pl. 149.—*a*. sporangia; *b*. fragment of sporangium-wall, and spores; *c*. spore (Scotland).

This species was separated by Rostafinski from *Licea*, and placed in the division *Amaurosporeae* as the type of a separate genus *Protoderma*, on account of the spores being 'dull violet'; but the examination of many specimens shows them to be olive-brown; Schrader's original place for the species is therefore retained.

Hab. On dead wood.—Surrey, Derbyshire, Yorkshire, Perthshire, Forfarshire, Aberdeenshire, Sweden, Germany, Switzerland, Poland.

4. **L. flexuosa** Pers. Syn. Fung., 197 (1801) (curved). Plasmodium dull yellow or rose-coloured. Sporangia scattered, pulvinate, depressed, or forming straight curved or branching plasmodiocarps 1 to 6 mm. long, either yellowish-brown and glossy, or dark brown and opaque when an outer layer of refuse-matter is present; sporangium-wall cartilaginous, translucent, pale purplish-brown, usually more or less overlaid with a thick mottled layer of olive-brown refuse-matter, dehiscing irregularly. Spores pale olive-brown, spinulose, with a thinner area of dehiscence, 11 to 14 μ diam., yellowish-brown or dull olive in mass.—Fr. Syst. Myc., iii. 197; Rost. Mon., 218. *L. variabilis* Schrad. Nov. Gen. Pl., 18, pl. 6, figs. 5, 6 (1797) ?; Macbr. N. Am. Slime-Moulds, ed. 2, 200. *L. Serpula* Fr. Symb. Gast., 12 (1817) ? *L. alutacea* Wallr. Fl. Crypt. Germ., ii. 344 (1833). *L. Schoenleinii* Johow Estud. Fl. Juan Fernandez, 195 (1896) ? *Tubulina flexuosa* Poiret in Lam. Encycl., viii. 131 (1808); Mass. Mon., 37. *Trichia variabilis* Poiret l.c. ?

Pl. 148.—*a*. plasmodiocarp (England); *b*. fragment of sporangium-wall and spores; *c*. spore.

In the field this species somewhat resembles *Enteridium liceoides*, and also *Dianema corticatum*; it differs from both in the rough granular deposits on the sporangium-wall which have a mottled effect as seen with transmitted light, and in the yellowish-brown colour of the spores. It sometimes occurs on old sawdust heaps in such abundance as to darken the sawdust over areas a foot or more across. *L. variabilis* Schrad. may refer to the present species, but both Fries and Rostafinski quote Schrader's description as referring to something different and doubtful, which they had not seen.

Hab. On dead coniferous wood, rarely on oak (S. Buchet): widely distributed in the British Isles and throughout Europe; recorded from New York, Pennsylvania, Ohio, Iowa (*teste* Macbride).

5. **L. biforis** Morgan in Journ. Cinc. Soc. Nat. Hist., xv. 131, t. 3, fig. 1 (1893) (having two flaps). Plasmodium watery-white then greyish. Sporangia scattered, forming minute ellipsoid or fusiform plasmodiocarps, attached by a long base, 0·2 mm. long, 0·05 to 0·1 mm. broad, glossy, yellow-brown, dehiscing along a thinner central ridge or depression; sporangium-wall membranous, minutely papillose, almost colourless, with scanty superficial deposits of discharged refuse-matter. Spores somewhat ovoid, the wall thinner on one side, 12 by 9 μ, almost colourless and smooth, pale ochraceous in mass.—Macbr. N. Am. Slime-Moulds, ed. 2, 201; Lister in Journ. Bot., xlii. 135.

Pl. 149.—*g.* six sporangia (Philadelphia); *h.* three sporangia; *i.* fragment of sporangium-wall and spores; *k.* spore.

This species is almost too small to be detected with the naked eye; when magnified one hundred times it bears considerable resemblance to a date-stone. Mr. K. Minakata has observed that young sporangia are copper-colour.

Hab. On dead wood.—Japan, Pennsylvania, Ohio, Canada.

6. **L. tenera** Jahn in Ber. Deutsch. Bot. Ges., xxxvi. 665, taf. xviii, figs. 4–6 (1919) (tender). Plasmodium ? Sporangia solitary or in groups, sessile, subglobose or ovoid, 0·4 to 0·5 mm. diam., shining olive-yellow; sporangium-wall a firm pale olive or dull yellow membrane, hardly cartilaginous, minutely areolated from spore-impressions, with scanty superficial deposits of refuse-matter. Spores pale olive-yellow, minutely spinulose, 10 to 12 μ diam., the wall thinner on one side.

Pl. 219.—*h.* two sporangia; *i.* part of sporangium-wall and four spores; *k.* spore.

Dr. Jahn describes a dozen inconspicuous sporangia developing in a culture on Sycamore bark (*Acer pseudoplatanus*) brought from Hohenschwangau, Oberbayern. A gathering on an elm-stick from Wanstead Park, Essex, December 1898, appears to be the same species; it consists of four glossy sporangia, three of which are partly confluent, attached to the stick by strands of dark hypothallus. It is closely allied to *L. flexuosa*, as Dr. Jahn remarks, and might easily be mistaken for the form of that species in which the superficial refuse deposits are absent.

Hab. On dead wood.—Essex, Bavaria.

Genus 32.—**HYMENOBOLINA** Zukal in Oester. Bot. Zeitschr., xliii. 133 (1893) (ὑμήν membrane, βόλος a casting). Sporangia solitary, sessile, brownish-grey, opening by a membranous lid. Sporangium-wall single, without lime. Capillitium none. Spores smooth, having the spore-wall thinner on one side. Plasmodium parasitic on lichens and algae.

H. parasitica Zukal l.c. Plasmodium rosy-red. Sporangia

scattered, sessile, subglobose or forming short plasmodiocarps, 0·05 to 0·2 mm. diam. brownish-grey, opaque or glossy, dehiscing irregularly or by a well-defined lid which is either smooth or areolated with prominent ridges ; sporangium-wall membranous, pale-purplish, minutely papillose on the inner surface of the lid or of all the wall, usually invested with a thick layer of refuse-matter in the lower part. Spores shining chestnut-brown in mass ; with transmitted light smooth, brown, subglobose, 11 to 16 μ diam., the spore-wall with a well-defined thin colourless area of dehiscence ; the contents of the freshly formed spore includes rosy granules.—*Hymenobolus parasiticus* Zukal l.c., 73, pl. v., figs. 1–10. *Licea singularis* Jahn in Ber. Deutsch. Bot. Ges., xxxvi. 665, t. xviii, 7–12 (1919).

Pl. 217.—*h.* fourteen sporangia and three plasmodia ; *i.* part of lid and opaque lower sporangium-wall ; *k.* spores.

This minute species is fully described by Zukal, who succeeded in cultivating the plasmodia on fragments of willow-bark. It is exceptional among Mycetozoa in the following characters : the amoeboid swarm-cells do not pass through a flagellate stage, and the plasmodium does not exhibit the characteristic rhythmic circulation of granular protoplasm, but instead shows slow irregular movements. The habit of the plasmodium also is remarkable ; instead of spreading in branching veins, each plasmodium forms a small nearly stationary mass which feeds on the lichen or alga lying beneath it, and into which it gradually penetrates. In dry weather each plasmodium contracts to form a spherical rose-coloured macrocyst 0·1 to 0·2 mm. diam., and then resembles the perithecium of a *Nectria*. The Rev. W. Cran has repeatedly found sporangia and macrocysts on lichens and algae growing on elder and ash bark in various parts of Aberdeenshire. The macrocysts soon revived on being moistened, and formed plasmodia that moved about slowly for some days in a moist chamber. There is no trace of capillitium in the sporangia we have examined, and it is probable that the threads Zukal described as capillitium were the hyphae of some minute mould. From the description and illustration of the spores of *Licea singularis* Jahn, there can be little doubt that they refer to the present species. *Hymenobolus*, the name first applied by Zukal, was found to be already appropriated ; he therefore changed it to *Hymenbolina*.

Hab. On moss and lichen on bark of dead or living trees.—Nairnshire, Aberdeenshire, Bavaria, Carinthia.

Genus 33.—**ORCADELLA** Wingate in Proc. Acad. Nat. Sci. Phil., 1889, 280 (diminutive of *orca* jar). Sporangia usually stalked ; sporangium-wall opaque with granular deposits except in the upper part where it forms a membranous lid.

1. **O. operculata** Wing. l.c. (with a lid). Plasmodium dull orange (Minakata). Total height 0·4 to 0·9 mm. Sporangia scattered, urn-shaped or subglobose, stalked, erect, 0·1 to 0·3 mm. diam., brown or nearly black, provided with a convex or dome-shaped dull yellow glossy lid, rarely sessile ; sporangium-wall cartilaginous, opaque from deposits of refuse-matter ; lid membranous, minutely papillose. Stalk cylin-

drical or subulate, furrowed, nearly black, filled with dark refuse-matter. Spores almost colourless and smooth, 8 to 11 μ diam., yellowish or pink in mass.—Mass. Mon., 49 ; Macbr. N. Am. Slime-Moulds, ed. 2, 203 ; Meylan in Bull. Soc. Vaud. Sc. Nat., liii. 460.

Var. **sessile** G. Lister. Sporangia sessile, pulvinate, glossy dark brown, dehiscing along one or more ridges ; spores lilac-pink.

Pl. 149.—*d.* sporangia ; *e.* fragment of sporangium-wall and papillose lid, with spores ; *f.* spore (United States).

This minute species was first found by Mr. Harold Wingate in Fairmount Park, Philadelphia, where it appeared in some abundance on oak bark. Sporangia found by Mr. W. H. Burrell at Stratton Strawless, Norfolk, differ from the type in having an ill-defined lid and in the walls being dark and cartilaginous at the base only, while above they are membranous, pale olive-brown, translucent and minutely papillose, and have a somewhat faceted appearance from being marked with superficial patches of refuse matter. Mr. Cran finds a similar form near Aberdeen, associated with sporangia having well-defined lids and with occasional sessile sporangia. The spore walls are colourless, but the contents are pale rose-coloured ; this rosy tint gives a striking appearance to the emerging swarm cells (see Burrell in Trans. Norf. & Norw. Nat. Soc., ix. 106). The form described as var. *sessile* was found on moss on an oak-tree, five feet from the ground, in December 1920, near Porlock, Somerset, by Mr. N. G. Hadden. The walls of the sporangia are equally thickened all over except along thinner prominent lines of dehiscence. In one sporangium two slender spikes enclosing dark refuse-matter project inwards from the walls, while a longer spike forms a bar, varying from 5 to 10 μ diam., crossing the sporangium and connecting the opposite walls. Possibly this is not a normal development ; the spores are, however, perfectly formed. Mr. Cran finds typical sporangia in great profusion on the mossy bark of living trees, five or six feet up the trunk, fully exposed to light and weather.

Hab. On moss and bark of living trees.—Norfolk, Aberdeenshire, North Germany, Jura Mountains, Japan, Pennsylvania, Maine : var. *sessile*, Somerset.

Family III.—Tubulinaceae.

Sporangia clustered, cylindrical or ellipsoid, stalked or sessile ; sporangium-wall membranous, pale rufous, without plasmodic granules ; spores minutely reticulated, 4 to 7 μ diam.

KEY TO THE GENERA OF *TUBULINACEAE*.

Sporangia cylindrical, compacted, with or without pseudo-columella. (34) Tubifera



Fig. 42.

Fig. 42.—*Tubifera ferruginosa* Gmel. Cluster of sporangia. Magnified 2½ times.

Sporangia clustered, stalked, ellipsoid ; capillitium a brush

of tubular threads attached above and below to the sporangium-wall. (35) ALWISIA

Fig. 43.—*Alwisia bombarda* Berk. & Br.

a. Three clusters of sporangia. Twice natural size.

b. Immature sporangium; the capillitium is seen through the transparent walls. (Drawn from a glycerine mounting.) Magnified 12 times.

c. Upper portion of three capillitium-threads, showing attachment to the sporangium-wall. Magnified 70 times.



Fig. 43.

Genus 34.—**TUBIFERA** Gmelin Syst. Nat., ii. 1472 (1791) (*tubus* tube, *fero* I bear). Sporangia cylindrical, crowded on a common hypothallus.

KEY TO THE SPECIES OF *TUBIFERA*.

A. Sporangia without pseudo-columella :—

Sporangia clustered on a broad hypothallus, spores 5 to 8 μ. 1. *T. ferruginosa*

Sporangia clustered on a stalk-like hypothallus, spores 3 to 5 μ. 2. *T. stipitata*

B. Sporangium-wall connected by tubular strands with a hollow pseudo-columella. 3. *T. Casparyi*

1. **T. ferruginosa** Gmel. l.c. (rust coloured). Plasmodium watery-white, rarely bright yellow, changing to salmon-colour or rose-red, then mulberry-red in the young sporangia. Sporangia densely crowded, cylindrical, angled by mutual pressure, seldom loosely clustered, convex or conical above, 3 mm. long, 0·4 mm. broad, light reddish-brown or umber, glossy or iridescent, seated on a common spongy hypothallus and forming rufous-brown cushions, 2 to 7 cm. in breadth; sporangium-wall membranous, pale rufous-brown, marked on the inner side with minute scattered warts or papillae and often with pouch-like protuberances. Spores pale rufous-brown, closely and minutely reticulated over two-thirds of the surface, the remaining third nearly smooth, or marked with broken ridges, 5 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 206. *T. cylindrica* Gmel. l.c. *T. fragiformis* Gmel. l.c. *Stemonitis ferruginosa* Batsch Elench. Fung., 261, fig. 175 (1786). *Lycoperdon favaceum* Schrank Baier. Fl., ii. 667 (1796). *Tubulifera ceratum* Müll. Fl. Dan., t. 659, fig. 2 (1777) ? (*nomen*). *T. arachnoidea* Jacq. Misc., i. 144, t. 15 (1778) ? *T. coccinea* Trentep. in Roth Catal. Bot., i. 243 (1797). *Sphaerocarpus cylindricus* Bull. Champ., 140, t. 470, fig. 3 (1791). *S. fragiformis* Bull. l.c., 141, t. 384. *Tubulina*

fragiformis Pers. in Roemer N. Mag. Bot., i. 91 (1794); Lister Mycetozoa, 153. *T. fallax* Pers. Obs. Myc., ii. 28 (1799). *T. cylindrica* DC. Fl. Fr., ii. 249 (1805); Rost. Mon., 220; Rex in Bot. Gaz., xv. 315; Mass. Mon., 39. *T. fragifera* Poiret in Lam. Encycl., viii. 130 (1808). *T. conglobata* Preuss in Linnaea, xxiv. 140 (1851). *T. nitidissima* Berk. in Journ. Linn. Soc., xviii. 387 (1881). *T. speciosa* Speg. in Atti Soc. Critt. Ital., ser. 2, iii. 62 (1881). *Licea clavata* Schrad. Nov. Pl. Gen., 18 (1797). *L. Tubulina* Schrad. l.c., 16. *L. fragiformis* Nees Syst., 107 (1816). *L. cylindrica* Fr. Syst. Myc., iii. 195 (1829). *L. iricolor* Zoll. in Flora, xxx. 300 (1847). *L. rubiformis* Berk. & Curt. in Proc. Am. Acad. Arts & Sci., iv. 125 (1860).

Pl. 150.—*a*. tubular sporangia clustered on a spongy barren base; *b*. spores; in two the side is shown on which the reticulation is imperfect (England); *c*. part of a cluster of sporangia with conical summits (United States).

The substance of the sporangium-wall varies in different gatherings; it may be iridescent and delicately membranous, or firm and of considerable thickness. As the young thin-walled sporangia mature their colour changes from rose-red to chestnut-brown; in stouter forms the young sporangia change from dark mulberry-red to dark brown (see Rex l.c., 318). In some sporangia of the more fragile type the apex is produced into a sharp cone; in others the sporangia are cylindrical, obtuse, and slightly connected with each other, those on the outside of the cluster being often entirely free; in the stouter type the walls are closely compacted, and their apices form a level tesselated surface. This species is often infested by the larvae of a small fly, one of the *Mycetophagidae*, which devour the spores and pupate within the cushions of sporangia.

Hab. On dead wood: common in the British Isles and widely distributed in temperate and tropical regions.

2. **T. stipitata** Macbr. N. Am. Slime-Moulds, 157 (1899) (stalked). Plasmodium white or colourless (*teste* Rex). Sporangia in shape, size, and colour as in *T. ferruginosa*, but clustered on a dark brown spongy hypothallus, which has the form of a stout stalk 2 to 3 mm. high. Spores pale rufous-brown, minutely reticulated over the greater part of the surface, the remaining part smooth or marked with ridges, 3 to 5 μ diam.—*Licea stipitata* Berk. & Rav. ex Berk. & Curt. in Proc. Am. Acad. Arts & Sci., iv. 125 (1860). *L. microsperma* Berk. & Curt. in Grev., ii. 68 (1873). *Tubulina stipitata* Rost. Mon., 223 (1875); Rex in Bot. Gaz., xv. 318; Mass. Mon., 38; Lister Mycetozoa, 154.

Pl. 150.—*d*. cluster of sporangia on a stalk-like base; *e*. spores, one shows the side on which the reticulation is imperfect (United States).

The conical form of *T. ferruginosa* has spores measuring 4 to 6 μ, and represents a form intermediate between that and the present species. Mr. Petch describes a Ceylon gathering in which the sporangia occur singly or in groups of three to twelve or more; in some clusters the outer sporangia are reflexed as in *Alwisia bombarda*; the 'stalk' may be 3 mm. high or almost absent (see Petch in Ann. Perad., iv. 357).

Hab. On dead wood: not uncommon in the United States, the West Indies, Japan, and throughout the tropics.

3. **T. Casparyi** Macbr. N. Am. Slime-Moulds, 157 (1899) (J. X. R. Caspary (1818–87), a German mycologist). Plasmodium white. Sporangia closely compacted, resembling *T. ferruginosa* in shape, size, and colour; sporangium-walls connected with a long central columella by numerous straight tubular processes. Spores pale rufous-brown, closely reticulated over the greater part of the surface, loosely reticulated over the remaining part, 6 to 7 μ diam.—*Siphoptychium Casparyi* Rost. Mon., App. 32 (1876); Rex in Bot. Gaz., xv. 319; Mass. Mon., 89; Lister Mycetozoa, 155.

Pl. 150.—*f.* portion of two sporangia with their walls partially broken away, showing the columella and capillitium; *g.* portion of columella and capillitium; *h.* spores, two show the side on which the reticulation is lax (United States).

Dr. Rex suggested that the columella in this species might be viewed as an aborted sporangium since 'aethalia are found in which from one-third to one-half of the component sporangia lack both columellas and connecting threads' (l.c.); but the constancy of the typical structure in specimens from many parts of the world does not support this view. Variations, however, do occur. In a large specimen gathered in Japan by Mr. K. Minakata the apical caps of the sporangia consist of a firm membrane to which the columellae are attached; the latter have few horizontal branches and are either rod-like or are broken up into a sheaf of slender knotted strands connected by numerous cross branchlets.

Hab. On dead wood.—Sweden, Japan, Ontario, New England, Iowa, Washington.

Genus 35.—**ALWISIA** Berkeley & Broome in Journ. Linn. Soc., xiv. 86 (1873) (H. de Alwis Seneviratne, for many years draughtsman to the Ceylon Botanic Gardens; died 1894). Sporangia clustered, stalked, ellipsoid; sporangium-wall falling away in the upper half and exposing a stiff brush of capillitium threads.

1. **A. bombarda** Berk. & Br. l.c., 87 (a stone-throwing engine, or bomb). Plasmodium watery-white. Total height 4 mm. Sporangia in clusters of four to eight, stalked, cylindrical-ellipsoid, 1 to 1·5 mm. high, 0·5 mm. broad, rufous-brown, the outer sporangia of a cluster usually reflexed; sporangia opening by spreading lobes; sporangium-wall membranous, evanescent above, persistent below, pale red, with minute scattered granules on the inner side, occasionally produced into small pouches. Stalks cylindrical, 2·5 mm. high, 0·15 mm. thick, adhering in clusters of 4 to 12, brownish-purple; when mounted in glycerine, orange-red, translucent. Capillitium consisting of slender straight and nearly simple tubular threads 0·5 to 0·8 mm. long, 3 to 8 μ wide, attached above by slender points to the fugaceous apical sporangium-wall, and also below to the interior of the cup-like base of the sporangium, where they often branch and anastomose; they

may be interrupted by bulbous swellings 20 to 40 μ long, and are either smooth or closely studded with slender spines 2 to 3 μ in length. Spores pale reddish-brown, reticulated over two-thirds their surface, 5 to 6 μ diam.—Lister in Journ. Bot., xlii. 135; Fischer in Mitth. Naturf. Ges. Bern., 1906, 121, figs. 11–14 (1907); Petch in Ann. Perad., iv. 357; Macbride N. Am. Slime-Moulds, ed. 2, 208. *Trichia fragilis* Rost. Mon. App., 39, (1876) in part. *Prototrichia bombarda* Mass. Mon., 128 (1892).

Pl. 151.—*a*. three clusters of sporangia (Ceylon); *b*. cluster of sporangia, the upper walls have broken away exposing the capillitium-threads (Jamaica); *c*. group of capillitium-threads attached above and below to the sporangium-walls; *d*. upper ends of three threads of capillitium, and spores; *e*. lower ends of capillitium-threads showing attachment to the sporangium-wall; *f*. part of capillitium-thread and spores.

On maturity the cup of the sporangium splits into reflexed lobes bearing the persistent threads of the capillitium in the form of a diffuse tuft. The type of this remarkable species is an immature gathering made by Thwaites in Ceylon in 1868. Although differing from the other species of the *Tubulinaceae* in the mode of dehiscence and in the capillitium, it agrees with them completely in the colour and structure of the sporangium-wall and in the character of the spores. Mr. A. R. Sanderson, who has collected this species three times in Malaya, and who was the first to observe the colour of the plasmodium, writes that it occurs on moss-covered rotten jungle-logs, sometimes forming very large colonies.

Hab. On dead wood.—Ceylon, Malaya, Sumatra, Jamaica.

Family IV.—Reticulariaceae.

Sporangia closely compacted and usually forming an aethalium; sporangium-walls without plasmodic granules, usually incomplete, perforated, or forming a spurious capillitium; true capillitium none, or in *Liceopsis* consisting of a few branching threads and strands.

KEY TO THE GENERA OF *RETICULARIACEAE*.

A. Sporangia forming aethalia* :—

Sporangia columnar; sporangium-walls incomplete, dome-shaped at the apex, continued down to the base in four to six straight threads. (36) Dictydiaethalium.

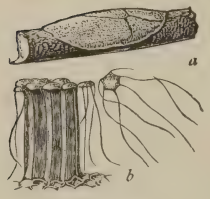


Fig. 44.

Fig. 44.—*Dictydiaethalium plumbeum* Rost.

a. Aethalium. Natural size.

b. Eight sporangia of an aethalium isolated; in three the column of spores has fallen away, leaving the cap and persistent threads. Magnified 20 times.

* Sporangia form elongated or net-like plasmodiocarps in *Enteridium liceoides*.

Walls of convoluted sporangia perforated and forming a uniform tissue of interarching bands.

(37) ENTERIDIUM

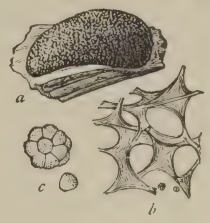


Fig. 45.

Fig. 45.—*Enteridium olivaceum* Ehrenb.

a. Plasmodiocarp. Magnified twice.

b. Part of spurious capillitium. Magnified 35 times.

c. A spore cluster, and one isolated spore. Magnified 210 times.

Walls of convoluted sporangia incomplete, forming strands and folds with numerous anastomosing threads.

(38) RETICULARIA



Fig. 46.

Fig. 46.—*Reticularia Lycoperdon* Bull.

a. Aethalium. Natural size.

b. Fragment of capillitium. Magnified 100 times.

B. Sporangia subglobose, closely compacted or forming aethalia ; inner walls usually complete.

(39) LICEOPSIS



Fig. 47.

Fig. 47.—*Liceopsis lobata* Torrend.

a. Two groups of sporangia. Magnified 5 times.

b. Capillitium. Magnified 50 times.

c. Spore. Magnified 450 times.

Genus 36.—**DICTYDIAETHALIUM** Rostafinski Versuch, 5 (1873) (δικτύδιον a little net, *aethalium* the term for a compound fructification). Aethalium pulvinate, formed of erect columnar sporangia ; sporangium-walls incomplete, dome-shaped at the apex, continued down to the basal membrane in four to six straight threads ; capillitium none. *CLATHROPTYCHIUM* Rost. Mon., 225 (1875).

1. **D. plumbeum** Rost. Versuch, 5 (1873) (lead-coloured).

Plasmodium rose-red. Aethalium pulvinate, smooth, flattened, 1 to 5 cm. broad, 0·5 to 1 mm. thick, dull slate-coloured or clay-coloured, iridescent, areolated with the convex apices of the sporangia, often surrounded by a white membranous hypothallus ; sporangia cylindrical, angled by mutual pressure, 0·5 to 1 mm. high, 0·2 mm. broad ; sporangium-wall ochraceous or yellow, persistent and forming a flat or dome-shaped cap at the apex, sometimes dark with superficial deposits of refuse-matter, continued down to the basal membrane in four to six straight threads 2 to 4 μ thick and triangular in section, evanescent between the threads. Spores clay-coloured in mass, when magnified pale yellow, spinulose, 9 to 12 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 215. *Fuligo plumbea* Schum. Enum. Pl. Saell., ii. 193 (1803). *Reticularia plumbea* Fr. Syst. Myc., iii. 88 (1829). *R. lurida* Berk. & Br. in Journ. Linn. Soc., xiv. 82 (1873). *Ostracoderma spadiceum* Schwein. in Tr. Am. Phil. Soc., ser. 2, iv. 262 (1831). *Licea rugulosa* Wallr. Fl. Crypt. Germ., ii. 345 (1833). *L. applanata* Berk. in Hook. Lond. Journ. Bot., iv. 67 (1845). *L. cinnabarina* Berk. & Br. l.c., 86 (1873). *L. tenuissima* Berk. & Br. l.c. *Lycogala lenticulare* Dur. et Mont. in Expl. Sc. de l'Algérie, 401 (1846). *Dictydiaethalium applanatum* Rost. in Fuckel Symb. Myc., Nachtr., ii. 69 (1873). *D. dissiliens* Hazsl. in Oester. Bot. Zeitsch., xxvii. 85 (1877). *Clathroptychium rugulosum* Rost. Mon., 225 (1875) ; Mass. Mon., 51. *C. cinnabarinum* Sacc. in Michelia, i. 545 (1879). *C. Berkeleyi* Mass. l.c., 53 (1892).

Var. **entoxanthum** G. Lister in Journ. Linn. Soc., Bot., xlvi. 95 (1922) (ἐντός within, ξανθός yellow). Aethalia pale or dark olive-green, 2 to 3 mm. thick ; spores bright yellow.—*Reticularia entoxantha* Berk. in Hook. Journ. Bot., iii. 201 (1851).

Pl. 152.—*a*. part of an aethalium seen from above ; *b*. tubular sporangia from an aethalium ; in two of them the spores are dispersed and the caps and threads of the sporangium-walls are left free ; *c*. sporangia from a stouter aethalium ; *d*. cap and threads of sporangium-wall ; *e*. floor of aethalium areolated with the bases of the sporangia ; *f*. spores and portion of a thread ; *g*. spores and portion of thread from aethalium drawn at *c*. (England) ; *h*. spore and thread of var. *entoxanthum* (Sikkim, K. 1669) ; *i*. spore (England) ; *k*. spore from type of *Clathroptychium Berkeleyi* Mass.

In this species the spores are dispersed by the threads giving way below and the sporangia separating in tufts from the persistent shining base of the aethalium. In irregular developments the sporangium-walls may be continuous to a great extent between the threads, forming a lattice work with wide expansions. The type of var. *entoxanthum* from Sikkim (K. 1660) is a robust form with an olive-black aethalium, 3 mm. thick, and bright yellow within ; the threads of the sporangia are 10 μ diam., waved and thickened at the margins ; the spores are yellow and spinulose, 9 to 11 μ ; similar aethalia have been obtained by Prof. Thaxter from Corral, Chili, but with more clay-coloured spores. *Clathroptychium Berkeleyi* Mass., from Ceylon (K. 1666), differs only from the robust forms of *D. plumbeum* in the more strongly spinulose spores ; but as the spores of most gatherings vary in roughness, this character alone is not sufficient to mark specific difference.

Clathroptychium cinnabarinum Sacc., from N. Italy, is described as having vermilion sporangia with blackish-purple opercula and threads; this description applies to immature specimens of *D. plumbeum*.

Hab. On dead wood: frequent in Great Britain in autumn and winter; widely distributed in all temperate and tropical regions: var. *entoxanthum* recorded from Sikkim, Ceylon, New Caledonia, and South Chili.

Genus 37.—**ENTERIDIUM** Ehrenberg in Spreng. Jahrb. Gewächs., i., pt. 2, 55 (1818) (ἔντερον intestine). Aethalium composed of confluent interwoven sporangia, their walls perforated with large openings; sporangia more or less free, forming plasmodiocarps in *E. liceoides*; capillitium none.

KEY TO THE SPECIES OF *ENTERIDIUM*.

A. Sporangia forming aethalia:—

Aethalia usually 1 cm. diam. or more; spores warted, clustered or free. 1. *E. olivaceum*

Aethalia 1 to 2 mm. diam.; spores warted, clustered. 2. *E. minutum*

Spores reticulated, free. 4. *E. Rozeanum*

B. Sporangia forming plasmodiocarps; spores clustered. 3. *E. liceoides*

1. **E. olivaceum** Ehrenb. l.c., 57 (olive). Plasmodium rose-red. Aethalium pulvinate, depressed, 1 mm. to 3 cm. broad, 1 to 3 mm. thick, smooth or rugulose, dark olive-brown, rarely dark bluish-green, often glossy; sporangium-walls yellow-olive or dark green, sub-cartilaginous, perforated with wide openings forming a network or pseudo-capillitium with broad winged boundaries to the meshes. Spores in clusters of 6 to 20, sometimes free, pale olive or brown, thickened and warted on one side, 9 to 12 μ diam.—Rost. Mon., 227; Mass. Mon., 44; Macbr. N. Am. Slime-Moulds, ed. 2, 214. *Lycoperdon ungulinum* Schum. Enum. Pl. Saell., ii. 192 (1803)? *Reticularia versicolor* Fr. Syst. Orb. Veg., i. 147 (1825). *R. olivacea* Fr. Syst. Myc., iii. 89 (1829). *R. ungulina* Fr. l.c.? *R. applanata* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 3, xviii. 56, t. ii, fig. 3 (1866). *Licea olivacea* Fuckel Symb. Myc., 338 (1869). *Licaethalium olivaceum* Rost. Versuch, 4 (1873). *Enteridium atrum* Preuss in Linnaea, xxiv. 142 (1851). *E. simulans* Rost. l.c., App. 30 (1876). *E. antarcticum* Speg. in Bol. Acad. Nac. Cienc. Cord., xi. 363 (1887)? *E. Rostrupii* Raunk. in Bot. Tidssk., xvii. 106 (1890). *E. macrosperma* Raunk. l.c.

Pl. 153.—*a*. aethalium; *b*. pseudo-capillitium and spore clusters; *c*. spore cluster.

The aethalia in this species may consist of many or few layers of sporangia; of the latter form an example is seen in *Enteridium Rostrupii* Raunk. from Denmark, in which parts of the large olive-grey aethalia consist of only

one or two layers of much branched loosely compacted sporangia. A specimen (B.M. 2813) obtained by Mr. W. B. Allen in the rosy plasmodium stage at Shirlett, Salop, and matured indoors, shows all stages between single spherical sporangia, 0·2 to 0·3 mm. diam., small subglobose aethalia 1 to 2 mm. diam., and larger aethalia 5 to 10 mm. long ; the spores are perfectly formed and free. This variety of forms from one plasmodium is probably due to unfavourable conditions of development.

Hab. On dead wood : not uncommon in the British Isles in autumn and winter ; widely distributed throughout Europe, and recorded also from New Jersey, and possibly from South Chili.

2. **E. minutum** Sturgis in Mycologia, ix. 329 (1917) (small). Aethalia subglobose or elongate, pale umber, 0·7 to 2 mm. diam. ; inner sporangium-walls or pseudo-capillitium pale brown, perforated by large rounded openings, or in part reduced to anastomosing strands. Spores pale yellowish-brown, globose or flattened on one side, minutely warted, 10×12 or $11 \times 13\ \mu$, loosely adhering in clusters of two to three.—Macbr. N. Am. Slime-Moulds, ed. 2, 214.

Pl. 220.—*a*. aethalium broken and showing pseudo-capillitium ; *b*. pseudo-capillitium, spores, and fragment of aethalium wall ; *c*, *d*. spores.

It appears somewhat doubtful if this is anything more than a small weak form of the preceding species which varies much in size and colour.

Hab. On dead wood.—Yorkshire, Colorado.

3. **E. liceoides** G. Lister in Guide to British Mycetozoa, ed. 4, 48 (1919) (*Licea*). Plasmodium rosy-pink. Sporangia usually forming curved plasmodiocarps, simple, branching, or sometimes forming a flat net, glossy, dark brown or purple-brown ; wall of aethalium purplish or brown, cartilaginous, consisting of two layers enclosing brown granular matter ; pseudo-capillitium represented by simple or forked columnar strands or tubes connecting the upper and lower sporangium-walls. Spores pale brown or olivaceous, clustered, minutely warted on the side facing outwards in the cluster, 10 to 12 μ diam.—*E. olivaceum* var. *liceoides* Lister in Journ. Bot., xxxiv. 211 (1896) ; Lister Mycetozoa, ed. 2, 197.

Pl. 153.—*d*. plasmodiocarps.

This species is found to be constant in the features which distinguish it from *E. olivaceum*. A curious intermediate form was gathered by the late Prof. W. G. Farlow at Chocorua, New Hampshire, consisting of a depressed aethalium, about 3 mm. diam. and 0·2 to 0·25 mm. thick, with dark brown rugged pseudo-capillitium in the form either of stout pillars or of branching and anastomosing strands enclosing refuse-matter.

Hab. On dead coniferous wood.—Devon, Somerset, Wiltshire, Surrey, Norfolk, Argyllshire, France, North Germany, New Hampshire.

4. **E. Rozeanum** Wing. in Proc. Acad. Nat. Sci. Phil., (1889) 156 (M. Roze who gathered the type). Plasmodium watery-white changing to flesh-coloured. Aethalium hemispherical or subglobose, 5 to 30 mm. diam., red-brown ; sporangium-walls within the aethalium perforated, forming a network of broad membranous bands, or sometimes frayed into strands

and slender threads as in *Reticularia*. Spores rusty-brown, closely and evenly reticulated on two-thirds of the surface, the remaining part faintly warted, 7 to 9 μ diam.—Macbr. in Bull. Nat. Hist. Iowa, ii. 117 ; Mass. Mon., 46. *Reticularia* (?) *Rozeana* Rost. Mon., App. 33 (1876). *R. splendens* Morg. in Journ. Cinc. Soc. Nat. Hist., xv. 137 (1893). *Enteridium splendens* Morg. in litt. ; Macbr. N. Am. Slime-Moulds, ed. 2, 211.

Pl. 153.—*e*. aethalium ; half is seen in vertical section, showing the persistent sporangium-walls and the barren base ; *f*. perforated sporangium-walls ; *g*. spores (United States).

Mr. Wingate states that specimens received by him from M. Roze, obtained from near Paris, identify the American gatherings with *Reticularia Rozeana* Rost., the type of which appears to be now lost. Prof. Macbride is of the opinion that Wingate's identification may have been incorrect, and prefers to use a later name, given by Morgan, *E. splendens*, for what is a common American species. There is no doubt, however, that the specimens from Philadelphia described by Wingate as *E. Rozeanum* are the present species, and we have not sufficient evidence to disturb the name he adopted. Typical examples have been gathered by Prof. Brandza in Moldavia.

Hab. On dead wood.—France, Moldavia, Japan, Ontario, British Columbia, and the United States.

Genus 38.—**RETICULARIA** Bulliard Champ., 95 (1791) (*reticulum* a little net). Aethalium composed of numerous elongated interwoven sporangia, whose walls are partly evanescent, partly persistent, and form broad expansions and strands dividing above into delicate capillitium-like threads ; spores and threads rusty-brown.

1. **R. Lycoperdon** Bull. l.c., t. 446, f. 4 (1791) (a genus of Puff-balls). Plasmodium creamy-white. Aethalium pulvinate or subglobose, 5 mm. to 6 cm. diam., brownish copper-coloured or enclosed in a thin smooth silvery cortex, seated on a well-developed hypothallus of interwoven membranous strands. Pseudo-capillitium consisting of persistent portions of the sporangium-walls, forming irregular branching strands arising from the hypothallus, dividing above into numerous slender flattened and flexuose rusty-brown threads. Spores free or adhering loosely in large clusters, somewhat turbinate, rusty-brown, thickened and closely reticulated on the rounded side, the remaining part marked with scattered warts, 6 to 10 μ diam.—Rost. Mon., 240 ; Mass. Mon., 93 ; Macbr. N. Am. Slime-Moulds, ed. 2, 210. *R. argentea* Poiret in Lam. Encycl., vi. 183 (1804). *R. umbrina* Fr. Syst. Myc., iii. 87 (1829). *Mucor Lycogalus* Bolton Hist. Fung., iii. 133, t. 133, f. 2 (1789). *Lycogala argentea* Pers. in Roemer N. Mag. Bot., i. 87 (1794). *L. turbinata* Pers. Syn. Fung., 158 (1801). *L. punctata* Pers. l.c. *Fuligo Lycoperdon* Schum. Enum. Pl. Saell., ii. 193 (1803). *Strongylium fuliginoides* Ditm. in Schrad. Neu. Bot. Journ., iii. 3 (1809).

Var. **jurana** G. Lister (from the Jura Mountains). Aethalium small, copper-coloured, with rather paler spores than in the typical form.—*R. jurana* Meylan in Bull. Soc. Vaud. Sc. Nat., xliv. 297 (1908).

Pl. 154.—*a*. aethalium; *b*. capillitium; *c*. spores (England).

When matured in a moist atmosphere under a glass shade, the smooth silvery cortex formed by a layer of barren sporangia is not produced, and the convolute sporangia are filled with spores to their apices, which gives an uneven brain-like surface to the aethalium. In some gatherings the walls of the sporangia are much more developed than in others, and have almost the character of *Enteridium*, to which genus *Reticularia* is closely allied. M. Meylan has courteously sent us specimens of what he regards as a new species, *R. jurana* (B.M. 2824), obtained from several stations in the Jura Mountains, at an elevation of from 1,300 to 1,500 m.; he gives as the distinguishing characters the small size of the aethalia, which measure 5 to 10 mm. diam., their fragile copper-coloured surface walls, and the faint reticulation of the paler spores. Similar aethalia are not unfrequent in the British Isles, and appear to be small forms of *R. Lycoperdon* hardly deserving varietal distinction.

Hab. On dead wood.—Common in the British Isles from spring to early autumn; widely distributed in all temperate regions.

Genus 39.—**LICEOPSIS** Torrend in Bull. Soc. Portug. Sci. Nat., ii. 63 (1908) (*Licea* and ὄψις appearance). Sporangia closely compacted, sessile, subglobose, with fragile membranous walls. Capillitium either consisting of slender branching threads and strands with membranous expansions at the axils, or wanting.

1. **L. lobata** Torrend l.c. (lobed). Plasmodium watery-white. Sporangia closely clustered, angled by mutual pressure, rarely solitary, subglobose, 0·4 to 0·7 mm. diam., rusty-brown, shining iridescent, sometimes confluent to form a flat or globose aethalium; sporangium-walls membranous, smooth. Capillitium scanty, consisting of slender rusty-brown branching and anastomosing threads and strands with thin membranous expansions. Spores subglobose or turbinate, rusty-brown, sharply and closely reticulated on two-thirds of their surface, faintly and loosely reticulated on the remaining third, 6 to 10 μ diam.—Torrend Fl. Myx., 121. *Reticularia lobata* Lister Mycetozoa, 161 (1894). *R. Rozeana* Lister in Journ. Bot., xxix. 263 (1891).

Pl. 154.—*d*. clustered sporangia (England); *e*. capillitium; *f*. spores.

This species appeared in July 1887 and in the three following years on a Spanish chestnut stump in Wanstead Park, Essex; it has since been obtained in many other localities. Gatherings made by Dr. Torrend on old willows, near Lisbon, show sporangia which do not unite to form true aethalia, as they do in some of the Wanstead specimens; in a few cases they are quite free, and may even be seated on slender stalks or strands of hypothallus. The small size and occasional free sporangia appear to be the chief characters distinguishing this species from *Enteridium Rozeanum*.

Hab. On dead wood.—Wanstead and Epping Forest, Essex, Surrey,

Bedfordshire, Derbyshire, Cheshire, Staffordshire, Salop, Norfolk, Aberdeenshire, North Wales, France, Germany, Portugal, Switzerland.

Family V.—Lycogalaceae.

Sporangia forming an aethalium ; pseudo-capillitium consisting of smooth or wrinkled branching colourless tubes.

(40) Lycogala

This order contains the single genus *Lycogala*.

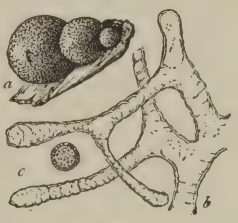


Fig. 48.

Fig. 48.—*Lycogala epidendrum* Fr.
a. Three aethalia. Natural size.
b. Capillitium. Magnified 150 times.
c. Spore. Magnified 600 times.

Genus 40.—**LYCOGALA** Adanson Fam. Pl., ii. 7 (1763) (λύκος wolf, γάλα milk). Aethalium subglobose or conical, with a cortex consisting of two or more closely combined layers of different structure ; the outer layer has large cell-like vesicles, which are either embedded or superficial, and is traversed by interlacing tubular threads which pierce the homogeneous inner layer, and are continuous with the tubes of the pseudo-capillitium ; the latter are grey or colourless, wrinkled or nearly smooth.

The plasmodium of *Lycogala epidendrum* emerges from decaying wood to form an aethalium as a group of small coral-red papillae ; these grow and unite into a cushion-like mass composed of numerous slender convoluted sporangia from 0·5 to 0·7 mm. diam. The sporangia are bounded at first by extremely delicate walls ; narrow branching air passages also lie in the interstices between them, which eventually are enclosed by membranous walls and constitute the pseudo-capillitium. Sections of young aethalia at various stages of growth show the formation of the complex structure of the cortex. The outer layer of the cortex is formed from the superficial coils of the sporangia and eventually consists of a membrane traversed by a weft of branching tubes containing air ; these tubes originated as air spaces between the outer barren layers of sporangia which have become flattened and contracted on themselves. The inner layer of the cortex is a finely granular membrane pierced by tubes continuous on the outside with those of the outer cortical layer, and on the inside with the pseudo-capillitium. Over the surface of the cortex are scattered numerous wart-like vesicles, which, when first formed, contain granular protoplasm with many nuclei, which degenerate and disappear as the vesicles dry. The pseudo-capillitium in *L. flavo-fuscum* has more delicate walls than in *L. epidendrum* and is sometimes perforated by irregular lattice-like openings. The occasional presence of spores in the tubes in *L. flavo-fuscum* may be explained by the penetration of sporeplasm through such openings.

KEY TO THE SPECIES OF *LYCOGALA*.

Cortex of aethalia smooth or areolated. 1. *L. flavo-fuscum*

Cortex of aethalia warted—

Aethalia subglobose. 2. *L. epidendrum*

Aethalia conical. 3. *L. conicum*

1. **L. flavo-fuscum** Rost. Versuch, 3 (1873) (*flavus* yellow, *fuscus* dusky). Plasmodium white or pale pink. Aethalia usually solitary, rounded, sessile, or pyriform and shortly stalked, 2 to 7 cm. diam., glossy, ochraceous or pale purplish-brown, minutely areolated; cortex thick, of three layers; the outer membranous, composed of interwoven barren sporangia; the middle consisting of several layers of vesicles with ochraceous granular contents, 50 to 80 μ diam., bounded on the inner side by a network of tubes containing air; the inner layer a pale brown homogeneous membrane, pierced by these tubes. Stalk a slender, colourless, more or less cylindrical strand of hypothallus, 1 to 2 cm. long. Pseudo-capillitium consisting of irregularly branching and anastomosing tubes, nearly colourless, smooth or somewhat wrinkled and papillose, 6 to 20 μ diam., with numerous wide expansions at the axils and with free rounded ends. Spores in mass pale buff, when magnified colourless, minutely reticulated over the greater part of the surface, 5 to 6 μ diam.—Rost. Mon., 288; Mass. Mon., 124; Zopf in Schenk Handb. Bot., iii, pt. 2, 167; Macbr. N. Am. Slime-Moulds, ed. 2, 234; Bambeke Contr. l'Hist. Lycogala flavo-fuscum (1912). *Diphtherium flavo-fuscum* Ehrenberg Sylv. Myc. Berol., 14, 27 (1818). *Reticularia flavo-fusca* Fr. Syst. Myc., iii. 88 (1829). *R. testacea* Wallr. Fl. Crypt. Germ., ii. 340 (1833)? *Lycogala repletum* Morg. in Journ. Cinc. Soc. Nat. Hist., xviii. 40 (1895)? *L. Rostafinskii* Siemaszko in Rocznika, xlvii. 249, t. v (1922)?

Pl. 155.—*a*. aethalium; *b*. reticulated surface of cortex; *c*. vertical section of cortex; (1) outer layer composed of interwoven empty flattened tubes; (2) vesicles containing yellow or reddish-yellow matter, with the interspaces between them traversed by tubular processes which are more or less continuous with the pseudo-capillitium; (3) homogeneous inner layer, perforated by the pseudo-capillitium; *d*. pseudo-capillitium consisting of empty tubes, occasionally containing spores in the rounded ends; two large isolated vesicles are also shown; *e*. part of pseudo-capillitium tube, showing papillose surface; *f*. spores, showing unequally distributed reticulation.

In this species large isolated vesicles filled with granular matter and measuring from 50 to 100 μ diam. are often found scattered among the spores. The description of *L. Rostafinskii*, the type of which was found on a trunk of *Fagus orientalis* in the Caucasus, applies well to the stalked form of *L. flavo-fuscum*.

Hab. On dead wood, especially within hollow elm-trees in England: recorded from Hampshire, Bedfordshire, Surrey, Salop, Nottinghamshire, Yorkshire, and Westmorland; from Sweden, France, Germany, Poland, and Austria; from the Cape Province, Ceylon, and Japan; not common but widely distributed in North and South America.

2. **L. epidendrum** Fries Syst. Myc., iii. 80 (1829). (ἐπί upon, δένδρον tree). Plasmodium coral-red, rarely white, cream-coloured, or yellow. Aethalia crowded or scattered, subglobose, sessile, 3 to 15 mm. diam., pinkish-grey, yellowish-brown, red-brown or nearly black, minutely warted ; cortex varying in thickness, minutely warted with irregular superficial vesicles. Pseudo-capillitium arising from the inner side of the cortex in the form of loosely branching and anastomosing thin-walled tubes, varying from 3 to 20 μ diam., usually marked with close transverse wrinkles; free branches numerous, clavate or rounded at the ends. Mass of spores pinkish-grey or pink, becoming ochraceous with age ; spores almost colourless, closely reticulated over the greater part of the surface, the remaining part marked with a loose reticulation or with short raised lines and warts, 4 to 7 μ diam.—Rost. Versuch, 3, & Mon., 285 ; Mass. Mon., 121 ; Macbr. N. Am. Slime-Moulds, ed. 2, 233. *Lycoperdon Epidendrum* Linn. Sp. Pl., 1184 (1753) ; Bull. Champ., 145, t. 503. *L. pisiforme* Jacq. Misc. Austr., i. 119, t. 7 (1778). *L. variolosum* Huds. Fl. Angl., ed. 2, 645 (1778). *L. chalybeum* Batsch Elench. Fung., 155 (1783). *L. pineum* Batsch l.c. ? *L. verrucosum* Batsch l.c. *Mucor Lycogala* Scop. Fl. Carn., ii. 496 (1772). *M. fragiformis* Schaeff. Fung. Bav., iv. 132 (1770). *Galoperdon epidendrum* Wiggers Fl. Holsat., 109 (1780). *Lycogala miniatum* Pers. in Roemer N. Mag. Bot., i. 87 (1794) ; Lister Mycetozoa, 209 *L. punctata* Pers. Syn. Fung., 158 (1801) ? *L. ferruginea* Schum. Enum. Pl. Saell., ii. 192 (1803). *L. cinerea* Schum. l. c., 193 ? *L. plumbea* Schum. l.c. ? *L. affine* Berk. & Br. in Journ. Linn. Soc., xiv. 82 (1873). *L. platense* Speg. in Anal. Mus. Nac. Buenos Aires, vi. 203 (1898–9) ? *Reticularia rosea* DC. in Bull. Soc. Philom., i. 105, fig. 8 A, B, C (1798). *R. miniata* Poiret in Lam. Encycl., vi. 184 (1804). *R. punctata* Poiret l.c.

Var. **exiguum** Lister in Minakata in Bot. Gaz. Tokyo, xxvii. 415 (1913) (small). Aethalia small, pale or dark, 2 to 5 mm. diam. ; spores usually rosy-pink.—*L. exiguum* Morgan in Journ. Cinc. Soc. Nat. Hist., xv. 134 (1893); Macbr. l.c., ed. 2, 235.

Var. **tessellatum** Lister in Penz. Myx. Buit., 77 (1898) (with tessellated surface as in mosaic). Aethalia dark brown, 2 to 10 mm. diam. ; superficial vesicles of the cortex dark, lobed, flattened, divided into numerous polygonal chambers 20 to 50 μ diam., and one or two layers deep.

Pl. 156.—*a.* aethalia ; *b.* surface of cortex, warted with vesicles ; *c.* vertical section of cortex ; (1) upper layer containing interwoven thick-walled tubes, and bearing on the surface simple or compound vesicles ; (2) homogeneous inner layer, perforated by the pseudo-capillitium ; *d.* pseudo-capillitium, consisting of empty tubes, rugose with transverse folds ; *e.* part of pseudo-capillitium tube, and spores.

In small aethalia the cortex is usually thin, the interlacing threads in the outer layer narrow and sparsely distributed, and the homogeneous inner layer membranous ; in larger aethalia the outer layer is often 40 μ thick,

and the interlacing threads broad and abundant, with gelatinous outer walls 5 to 10 μ thick, while the homogeneous inner layer sometimes exceeds 50 μ in thickness. A form of var. *exiguum* with smooth pseudo-capillitium, and spores bright pink in mass was obtained in the province of Kii, Japan, by Mr. B. Nishino, who observed that the colour of the plasmodium was deep rose-red. Aethalia similar to those from Kii were gathered near New Haven, Conn., by Prof. Farlow. The characters distinguishing this form do not appear to be sufficiently constant to mark a separate species; smooth pseudo-capillitium may occur also in the var. *tessellatum*, and the spores are often pink in typical aethalia of *L. epidendrum*.

Hab. On dead wood, rarely on dead leaves: common in the British Isles in summer and autumn, and frequent in all temperate and tropical regions; the vars. *exiguum* and *tessellatum* are widely distributed.

3. **L. conicum** Pers. Syn. Fung., i. 159 (1801) (cone-shaped). Plasmodium rose-red or scarlet. Aethalia conical, sessile on a broad base, crowded or scattered, 1·5 to 3 mm. high, 0·8 to 1·5 mm. broad, sometimes subglobose, yellow-brown, marked with dark branching superficial vesicles which form spots or a broken reticulation chiefly on the upper part; cortex thin, of two closely combined layers; the outer traversed by flattened tubes, 2 to 10 μ broad, which are either loosely interlacing or nearly parallel in a single series and separated by intervals of 2 to 20 μ; the tubes pierce the membranous inner layer and are continuous with the pseudo-capillitium; the latter consisting of simple, rarely branching, olivaceous-grey tubes, 3 μ diam., or varying from 2 to 7 μ, faintly and minutely wrinkled, with clavate or obtuse ends. Spores yellowish-grey or ochraceous, minutely reticulated over the greater part of the surface, 4 to 5 μ diam.—Fr. Syst. Myc., iii. 82; Mass. Mon., 123; Macbr. in N. Am. Slime-Moulds, ed. 2, 236; Petch in Ann. Perad., iv. 361. *L. nitidum* Berk. & Br. in Journ. Linn. Soc., xiv. 81 (1873). *L. atropurpureum* Berk. & Br. l.c., 82. *Dermodium conicum* Rost. Mon., 284 (1875).

Pl. 157.—*a.* aethalia; *b.* part of cortex; (1) outer membranous layer, bearing on the surface irregularly shaped vesicles containing dark granular matter, and traversed by empty flattened tubes having a somewhat parallel arrangement; (2) homogeneous inner layer, perforated by the narrow pseudo-capillitium tubes; *c.* part of pseudo-capillitium tube, and spores (Ohio).

The aethalia in this species differ from those of *L. epidendrum* in their uniformly small size and more or less conical shape, in the scanty seldom branching somewhat parallel tubes of the outer layer of the cortex, and in the almost simple threads of the pseudo-capillitium. Very similar structure is met with in minute thin-walled aethalia of *L. epidendrum*, but such small aethalia are usually found associated with larger ones and differ also in the shape and arrangement of the superficial vesicles.

Hab. On dead wood.—Norway, Sweden, North Germany, Switzerland, Moldavia, Ceylon, Japan, West Indies, Pennsylvania, Ohio, Missouri.

Suborder II.—*CALONEMINEAE.*

Sporangia simple ; capillitium always present, forming a system of uniform threads ; spores yellow, red, or grey.

Family I.—Trichiaceae.

Capillitium consisting of tubular threads that are either free and are then called ' elaters ', or combined into an elastic network ; thickenings in the form of spirals or rings.

KEY TO THE GENERA OF *TRICHIACEAE.*

Capillitium abundant, consisting of free elaters with spiral thickenings. (41) Trichia

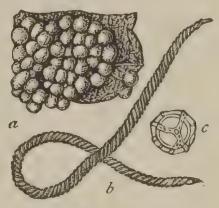


Fig. 49.

Fig. 49.—*Trichia affinis* de Bary.
a. Group of sporangia. Twice natural size.
b. Elater. Magnified 250 times.
c. Spore. Magnified 400 times.

Capillitium scanty, consisting of free elaters with imperfect spiral thickenings ; sporangia minute, closely compacted or heaped. (42) Oligonema



Fig. 50.

Fig. 50.—*Oligonema nitens* Rost.
a. Cluster of sporangia. Magnified 3 times.
b. Elater. Magnified 280 times.
c. Spore. Magnified 400 times.

Similar to *Oligonema*, but the capillitium branching and anastomosing to form a network. (43) Calonema

Capillitium combined into a network, with spiral thickenings. (44) Hemitrichia

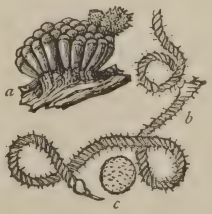


Fig. 51.

Fig. 51.—*Hemitrichia Vesparium* Macbr.
a. Cluster of sporangia. Magnified 2½ times.
b. Capillitium. Magnified 280 times.
c. Spore. Magnified 400 times.

Capillitium combined into a network, with thickenings in the form of rings. (45) CORNUVIA

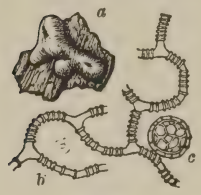


Fig. 52.

Fig. 52.—*Cornuvia Serpula* Rost.
a. Plasmodiocarp. Magnified 7 times.
b. Capillitium. Magnified 250 times.
c. Spore. Magnified 400 times.

Genus 41.—**TRICHIA** Haller Hist. Stirp. Helv., iii. 114 (1768) (θρίξ a hair). Sporangia stalked, sessile or forming plasmodiocarps; sporangium-wall membranous or cartilaginous; elaters free, pointed at each end, thickened with two to five spiral bands; spores reticulated or warted, in the former case the reticulation may be continuous or broken, and forms when seen in profile a 'border' to the spore.

A. Spores more or less completely reticulated :—

Elaters 6 to 8 μ wide; spores reticulated; border 2 μ wide; sporangia sessile. 1. *T. favoginea*

Elaters 4 to 6 μ wide; spores reticulated with narrow bands; border 1 μ wide; sporangia usually stalked, clustered. 2. *T. verrucosa*

Elaters 4 to 6 μ wide; spores reticulated with broad pitted bands; border 0·5 to 1 μ wide; sporangia sessile. 3. *T. affinis*

Elaters 4 to 6 μ wide; spores with the reticulation more or less broken into irregular shallow pitted warts; border interrupted, 0·5 μ wide; sporangia sessile. 4. *T. persimilis*

Elaters 4 to 6 μ wide; spores very closely reticulated; border almost none; sporangia sessile. 5. *T. scabra*

B. Spores minutely warted (sometimes minutely reticulated in *T. decipiens*) :—

a. Spirals of elaters two. 6. *T. varia*

b. Spirals of elaters three or more—

α. Elaters shortly tapering at the ends—

Sporangia sessile; wall pale or dark brown, uniformly thickened with granular matter; spirals of elaters distinct or faint. 7. *T. contorta*

Sporangia sessile; wall black, thick. 8. *T. alpina*

Sporangia sessile; wall thin, without granular thickening; spirals of elaters faint. 9. *T. lutescens*

Sporangia stalked; wall membranous, thickened in rounded areas with brown granular deposits; elaters spinose. 10. *T. erecta*

Sporangia stalked; elaters smooth. 13. *T. subfusca*

β. Elaters smooth, very gradually tapering at the ends; sporangia stalked—

Stalk filled with spore-like cells. 11. *T. decipiens*

Stalk brown, opaque, not filled with spore-like cells. 12. *T. Botrytis*

Stalk brownish-red or red, translucent when mounted. 14. *T. floriformis*

1. **T. favoginea** Pers. in Roemer N. Mag. Bot., i. 90 (1794) (*favus* honeycomb). Plasmodium white (or yellow, *fide* Macbride). Sporangia sessile, globose, ovoid, cylindrical or clavate, crowded on a membranous hypothallus, 0·6 to 0·7 mm. broad, 0·7 to 1·9 mm. high, shining ochraceous-yellow; mass of spores and capillitium orange-yellow; sporangium-wall membranous, thickened with delicate irregular striae. Capillitium consisting of long cylindrical elaters 6 to 8 μ diam., smooth or with scattered spines, thickened with four to five spiral bands 1 μ broad, the intervals between them crossed by slender ridges running parallel with the length of the elater; the ends of elaters conical, terminating in a smooth point 3 to 8 μ long. Spores yellow, the wall reticulated with narrow deep bands forming a net with three to five meshes to the hemisphere, 13 to 15 μ diam. including the border of 1·6 to 2 μ width.—Schum. Enum. Pl. Saell., ii. 207; Macbr. N. Am. Slime-Moulds, ed. 2, 272. *Lycoperdon gregarium* Retz. Fasc. Obs. Bot., i. 33 (1779)? *L. favogineum* Batsch Elench. Fung., Cont. 257 (1786)? *Stemonitis favoginea* Gmel. Syst. Nat., ii. 1470 (1791)? *Sphaerocarpus chrysospermus* Bull. Champ., t. 417, f. 4 (1791)? *Trichia nitens* Pers. Obs. Myc., i. 62 (1796)? *T. chrysosperma* DC. Fl. Fr., ii. 250 (1805)? Rost. Mon., 255; Mass. Mon., 189.

Pl. 159.—*a*. sporangia; *b*. two spores and part of elater (Freiburg, Germany).

The species of *Trichia* with reticulated spores are distinguished by somewhat arbitrary characters. The descriptions under the several names are taken from specimens named by Rostafinski in the Strasburg Herbarium; they represent well marked centres, but in this abundant and widespread genus intermediate forms are of frequent occurrence. The character of longitudinal striae connecting the bands on the elaters is met with to a greater or less extent in each member of the group. In extensive gatherings of the present species on old pine stumps in the Black Forest, the elaters are usually 8 μ diam., but some measure 7 μ and some 6·5 μ; the con-

necting striae are almost always but not invariably distinct; the spores have mostly unbroken bands without pits, and show a border 2 μ diam., but in some parts of several gatherings the bands are broader, broken, and pitted, and so shallow that the border is reduced to a slight thickening of the spore-wall; in all these specimens a considerable part retains the character of *T. favoginea* in the narrow and even bands on the spores and broad elaters. Between *T. favoginea* and *T. affinis*, *T. affinis* and *T. persimilis*, and *T. persimilis* and *T. scabra*, intermediate forms frequently occur. The length, branching, and markings of the elaters vary much with different conditions of development. Abnormal forms sometimes occur with the capillitium consisting of a dense network of the extreme *Hemitrichia* type with no free elaters. *T. affinis* and *T. scabra*, when exposed to severe changes of temperature at the time of their fruiting have the markings of the elaters chiefly in the form of rings instead of spirals. With such blending of form, which indicates a close relationship between all these species, the characters given in the key must be taken as approximate, marking the main centres around which the numerous varieties group themselves.

Hab. On decayed wood, usually of conifers: not common in the British Isles; recorded from Cornwall, Somerset, Warwick, Salop, Buckinghamshire, Forfarshire, and Co. Derry: widely distributed throughout Europe and the United States; recorded also from North West India, Japan, and South Chili.

2. **T. verrucosa** Berk. in Hooker Fl. Tasm., ii. 269 (1860) (warty). Plasmodium white. Total height 2 to 4 mm. Sporangia stalked, rarely sessile, pyriform or clavate, clustered or solitary, 1·4 mm. high, 0·8 mm. broad, ochraceous-yellow, mass of elaters and spores golden-yellow; sporangium-wall membranous, minutely and closely papillose on the inner side, pale yellow, sometimes with an outer layer thickened by granular deposits. Stalks membranous, 1 to 2 mm. high, usually combined in clusters of three or four, rugose, yellow-brown or dark brown. Capillitium of long cylindrical elaters, 4 to 6 μ wide, with short conical ends, marked with three to five narrow spiral bands, smooth, or with a few scattered spines; longitudinal striae distinct. Spores reticulated with narrow, minutely pitted bands, forming a network with about seven meshes to the hemisphere, 13 to 16 μ diam.; border 1 μ wide.—Mass. Mon., 191; Macbr. N. Am. Slime-Moulds, ed. 2, 273; Torrend Fl. Myx., 111. *T. superba* Mass. in Journ. R. Micr. Soc., (1889) 345; Mass. Mon., 194.

Pl. 161.—*a*. cluster of sporangia; *b*. elater and spore (Java).

Berkeley's type from Tasmania (K. 17750) is somewhat immature, but is sufficiently developed to be clearly identified as the same species as *T. superba* Mass. from New Zealand. A fine specimen of the same form from Chili, in the Strasburg Herbarium, was named by Rostafinski *T. chrysosperma* (syn. *T. favoginea*). *T. verrucosa* is no doubt closely allied to that species, but the characters of the stalked sporangia with papillose walls and of the spores marked with a rather close reticulation of narrow bands are constant.

Hab. On dead wood: recorded in the British Isles from Kent, Surrey, Essex, Hertfordshire, Derbyshire, Nottinghamshire, Yorkshire, North-

umberland, North and South Wales, Aberdeenshire; also from Portugal, Java, Tasmania, Victoria, New South Wales, New Zealand, Japan, Dominica, Washington State, Mexico, Brazil, South Chili.

3. **T. affinis** de Bary in Fuckel Symb. Myc., 336 (1869) (akin). Plasmodium watery-white. Sporangia globose or obovoid, sessile, usually crowded, often seated on a membranous hypothallus, 0·6 to 1 mm. diam., shining golden or ochraceous-yellow; mass of elaters and spores bright yellow; sporangium-wall membranous, pale yellow, marked with delicate irregular striae, rarely reticulated in a manner resembling fan-tracing. Capillitium consisting of long cylindrical elaters, 4 to 6 μ diam. with conical pointed ends, marked with four to five spiral bands, smooth, rarely studded with minute scattered spines; longitudinal striae usually present. Spores reticulated with broad, rarely narrow, pitted bands, forming a more or less complete net with three to five meshes to the hemisphere, 13 to 15 μ diam.; border 0·5 to 1 μ wide.—Rost. Mon., 257; Mass. Mon., 194. *T. Kalbreyeri* Mass. in Journ. R. Micr. Soc., (1889) 344; Mass. Mon., 191. *T. intermedia* Mass. in Journ. R. Micr. Soc., (1889) 341; Mass. Mon., 188. *T. pulchella* Rex in Proc. Acad. Nat. Sci. Phil., 1893, 366; Macbr. N. Am. Slime-Moulds, ed. 2, 273. *T. persimilis* Macbr. l.c., 271, in part.

Pl. 160.—*c.* sporangia; *d.* spores and elaters, one elater showing regular, the other irregular spiral bands (England).

This species is nearly allied to *T. persimilis*, with which it is united by Prof. Macbride; in Europe and the British Isles, however, the two centres are usually well distinguished. The type of *T. pulchella* Rex, from Philadelphia (B.M. slide), differs from the usual developments of *T. affinis* only in the more scattered habit of growth of the sporangia; the elaters are narrow, being 3·5 to 4·5 μ diam.; the spores have a border 1 μ wide and are reticulated with narrow, minutely pitted raised bands, presenting from three to four meshes on the hemisphere. The type of *T. Kalbreyeri* Mass., from New Granada (K. 1196), has elaters 5 μ diam., with delicate longitudinal striae, and spores marked with a rather close reticulation of broad, faintly pitted bands; it does not appear to differ from typical *T. affinis*. The type of *T. intermedia* Mass. from Scarborough has elaters 4 to 6 μ diam., and is almost identical with de Bary's type of *T. affinis* in the Strasburg Herbarium both in capillitium and spores. A form with elaters united to form a network as in *Hemitrichia* is not unfrequent in irregular developments; it has been named *H. helvetica* by M. Meylan (Bull. Soc. Vaud. Sc. Nat., xlvi. 54 (1910)).

Hab. On decayed wood and moss: common in the British Isles and in all temperate regions; recorded also from Ceylon and the Philippine Islands, but, like most members of the genus, rare in the tropics.

4. **T. persimilis** Karst. in Not. Saellsk. pro Fauna et Flora Fenn. Forh., ix. 353 (1868) (very like). Plasmodium watery-white. Sporangia globose, usually crowded and seated on a common membranous hypothallus, 0·5 to 0·8 mm. diam., brown or yellow-brown, shining; capillitium and spores in

mass yellow or yellow-brown ; sporangium-wall membranous, yellow, marked with delicate 'stippled' lines or rows of minute warts. Capillitium of cylindrical elaters 4 to 6 μ diam., marked with about four closely set spiral bands, usually studded with numerous short slender spines ; the ends of the elaters conical, acute, or with the spiral bands produced at the apex into two or three diverging points ; longitudinal striae inconspicuous. Spores yellow, or yellow-brown, 11 to 14 μ diam., with the reticulation broken, or represented by irregular pitted warts ; border interrupted.—Macbr. N. Am. Slime-Moulds, ed. 2, 271, in part. *T. Jackii* Rost. Mon., 258 (1875) ; Mass. Mon., 188. *T. proximella* Karst. in Bidr. Känn. Finl. Nat., iv. 139 (1879) ; Mass. l.c., 180. *T. abrupta* Cooke in Ann. Lyc. Nat. Hist. N. York, xi. 404 (1877) ; Mass. l.c., 187. *T. Balfourii* Mass. in Journ. R. Micr. Soc., (1889) 339 ; Mass. Mon., 186. *T. sulphurea* Mass. in Journ. R. Micr. Soc., (1889) 339 ; Mass. Mon., 186.

Pl. 160.—*a*. sporangia ; *b*. elater and spores (England).

In this abundant species the capillitium, when matured under unfavourable conditions, often shows great divergence from the usual type. The elaters in some cases are very short, measuring only 12 to 15 μ in length ; in others they may be long, branched and combined to form a *Hemitrichia*-like network. Dr. Karsten's type from Finland, agrees essentially with the examples of *T. Jackii* Rost. in the Strasburg Herbarium. The occurrence of the long spinous processes on the elaters, noted in the original description of *T. persimilis*, is not a constant character. A form with the ends of the elaters obtuse and the spiral bands continued at the apex into widely diverging spines has been named *T. abrupta* Cooke, but this character appears occasionally in *T. favoginea*, *T. affinis*, and *T. scabra*. *T. proximella* Karsten and *T. sulphurea* Mass. have elaters 4·5 to 5 μ diam., and spores with the bands much broken ; *T. Balfourii* Mass. has the elaters 4 to 5 μ diam., and the reticulation on the spores consists of wide, broken, and pitted bands. They present no character by which they can be separated from *T. persimilis*.

Hab. On dead wood : common in the British Isles throughout the year, and widely distributed in all temperate regions ; recorded also from Ceylon, Java, and Peru.

5. **T. scabra** Rost. Mon., 258 (1875) (rough). Plasmodium watery-white. Sporangia sessile, globose, usually crowded in large colonies on a membranous hypothallus, 0·6 to 0·9 mm. diam., shining orange-yellow, olivaceous or yellow-brown ; sporangium-wall membranous, yellow, marked with faint lines of minute warts or with fan-like tracery. Capillitium and spores in mass bright orange-yellow. Elaters long, cylindrical, bright yellow, 4 to 6 μ diam., marked with four or five often somewhat irregular spiral bands, studded with spines or nearly smooth, the ends acutely conical or with the bands produced at the apex in diverging points ; longitudinal striae rarely evident. Spores yellow, minutely and closely reticulated with shallow bands forming a complete or frag-

mentary net with about forty meshes to the hemisphere, rarely irregularly warted, 9 to 12 μ diam.—Mass. Mon., 192; Macbr. N. Am. Slime-Moulds, ed. 2, 271. *Trichia anomala* Karst. in Not. Saellsk. Faun. Fl. Fenn., ix. 354 (1868) ? *T. minima* Mass. in Journ. R. Micr. Soc., (1889) 336; Mass. Mon., 182. *T. nitens* Fries in MS.; Mass. in Journ. R. Micr. Soc., (1889) 333; Mass. Mon., 179. *Arcyria Bucknalli* Mass. l.c., 161. *Hemitrichia Bucknalli* Mass. in Grev., xviii. 27 (1889). *Oligonema aeneum* Karst. in Bidr. Känn. Finl. Nat., iv. 131 (1879) ? *Cornuvia anomala* Karst. l.c. ? *Oligonema fulvum* Morg. in Journ. Cinc. Soc. Nat. Hist., xvi. 36 (1893). *Ophiotheca anomala* Mass. l.c., 135 ? *Perichaena annulifera* Boudier in Bull. Soc. Myc., xviii. 144, pl. 8, fig. 3 (1893).

Pl. 159.—*c*. sporangia (England); *d*. spores and elaters; one of the latter shows regular, the other irregular spiral bands.

The type of *Arcyria Bucknalli* Mass., from Bristol (K. 1774), is an irregular form of the present species; the capillitium is spinose, and consists of long sparingly branched free elaters, not combined into a network; the spiral bands are in many parts entirely modified into rings, a character often seen in some degree in imperfect developments of this species; the spores are of the typical form of *T. scabra*. Another irregular growth, from Luton (B.M. slide), has the dense net of a *Hemitrichia* and no free elaters; the close and rugged spirals on the threads are in some parts replaced by rings. The type of *T. minima* Mass., from Oldham (K. 1044), has spinulose elaters 4 to 5 μ diam.; the spores measure 9 μ; some are delicately reticulated, in others the net is broken into warts and short bands; it is not an unusual form of *T. scabra*. The type of *T. nitens* Fr. from Upsala (K. 1104) has spores 9 to 10 μ diam., and either closely reticulated, or with the bands much broken; it appears to be a typical form of *T. scabra*, except that the elaters are rather more smooth than usual. The type of *Oligonema fulvum* Morgan, from Preston, Ohio (B.M. slide), is also *T. scabra*; the scanty capillitium consists of short, rather irregularly formed elaters, some of which have the usual spiral markings, while others are smooth; the spores are marked with the characteristic close reticulation, and measure 10 to 13 μ diam. The type of *Oligonema aeneum* Karst. from Finland, is not represented in the quoted collections; the description of the crowded olivaceous sporangia, smooth elaters marked with scattered ring-shaped thickenings, and warted, yellowish-ochre spores, suggests an irregular development of the present species. The description of *Trichia anomala* Karst. (syn. *Cornuvia anomala* Karst.) also suggests an abnormal growth of *T. scabra*. Judging by the careful drawing courteously sent by M. Boudier, *Perichaena annulifera* is also an imperfect development of the present species, with very faint spiral bands on the elaters which often fork or form loops and rings. The var. *lutea* Meylan (Bull. Soc. Bot. Genève, ser. 2, ii. 266 (1910)) is described as having brighter yellow spores and capillitium than in the typical form.

Hab. On stumps and dead wood: common in the British Isles from summer to winter; not unfrequent in North Temperate regions, recorded also from Ceylon.

6. **T. varia** Pers. in Roemer N. Mag. Bot., i. 90 (1794) (variable). Plasmodium white. Sporangia globose, ovoid or turbinate, 0·6 to 0·9 mm. diam., sessile, shortly stalked, or

forming short plasmodiocarps, crowded or scattered, ochraceous yellow or olivaceous, often forming very large colonies ; sporangium-wall membranous, pale yellow, marked with ring-shaped or crescentic thickenings. Stalks 0·1 to 0·5 mm. high, 0·2 to 0·3 mm. thick, black, furrowed. Capillitium of cylindrical ochraceous-yellow elaters, 3 to 5 μ diam., tapering shortly at the ends and terminating in a curved point, marked with two well defined spiral bands which are more prominent on one side of the elater than on the other. Spores ochraceous-yellow, minutely warted, 11 to 16 μ diam.—Rost. Mon., 251 ; Mass. Mon., 178 ; Macbr. N. Am. Slime-Moulds, ed. 2, 270. *Stemonitis varia* Pers. in Gmel. Syst. Nat., 1470 (1791). *Stemonitis vesiculosa* Gmel. Syst. Nat., 1468 (1791) ? *Mucor pyriformis* Scop. Fl. Carn., ed. 2, ii. 492 (1772) ? *Clathrus turbinatus* Huds. Fl. Angl., ii. 632 (1778) ? *Lycoperdon vesiculosum* Batsch Elench. Fung., Cont. i. 283 (1786) ? *Trichia ovata* Pers. Obs. Myc., i. 61 (1796) ? *T. olivacea* Pers. l.c., 62. *T. vulgaris* Pers. l.c., ii. 32 (1799) ? *T. cordata* Pers. l.c., 33. *T. cylindrica* Pers. l.c. *T. pyriformis* Pers. l.c. *T. turbinata* Sow. Engl. Fung., tab. 85 (1799) ? Fr. Syst. Myc., iii. 187 ? *T. nigripes* Pers. Syn. Fung., 178 (1801). *T. craterioides* Corda Icon., ii. 21, t. xii., f. 85 (1838). *T. aculeata* Čel. fil. Myx. Böhm., 34 (1893).

Pl. 164.—*a*. sporangia ; *b*. elater ; *c*. spore (England).

As in other species of the genus, forms of *T. varia* sometimes occur with either very long (cf. *T. varia* v. *aurata* Meylan in Bull. Soc. Vaud. Sc. Nat., xliv. 299 (1908)), or very short elaters, or the elaters may branch and combine to form a *Hemitrichia*-like network. The type of *T. aculeata* Čel. fil., from Bohemia (B.M. 2893), is an irregular form of the present species ; many of the elaters are very short and are attached to the sporangium-wall ; they are either marked with the usual spiral bands, or are smooth and reduced to spine-like processes. *T. varia* var. *fimicola* Marchal (Bull. Soc. R. Bot. Belg., xxxiv. 128 (1895)) is briefly described as appearing on hare's dung and having elaters 3 μ wide, and pale ochraceous spores 7 to 9·5 μ diam. The habitat is unusual for *T. varia* and it seems possible that the form should be referred to another species.

Hab. On dead wood : common in the British Isles, especially in autumn and winter ; common also throughout Europe and the United States ; widely distributed in all temperate regions and recorded from Ceylon, Teneriffe, and North India.

7. **T. contorta** Rost. Mon., 259 (1875) (twisted). Plasmodium watery-white. Sporangia clustered or scattered, subglobose, 0·5 to 0·8 mm. diam., sessile, often forming curved plasmodiocarps, rarely provided with a very short black stalk, dull yellow-brown or dark red-brown ; sporangium-wall membranous or cartilaginous, yellow, or reddish-brown, charged with brown granular matter, rarely with deposits of angular crystals of lime, when the sporangia are grey. Capillitium of simple or branched elaters, with four or five

often indistinct or rugged spiral bands, 3 to 5 μ diam., the tips usually swollen and ending in a curved point, yellow or yellow-brown. Spores yellow, minutely spinulose, 10 to 14 μ diam.—Mass. Mon., 182; Macbr. N. Am. Slime-Moulds, ed. 2, 269. *Lycogala contortum* Ditm. in Sturm Deutsch. Fl., Pilze, i. 9, t. 5 (1813). *Perichaena contorta* Fr. Syst. Myc., iii. 192 (1829). *Licea contorta* Wallr. Fl. Crypt. Germ., ii. 345 (1833). *Trichia reniformis* Peck in Rep. N. York Mus., xxvi. 76 (1874). *T. heterotrichia* Balf. in Grev., x. 117 (1881). *T. pachyderma* Čel. fil. Myx. Böhm., 38 (1893). *T. intermedia* Čel. fil. l.c. *T. ovalispora* Hollós in Math. Nat. Wiss. Ber. Ung., xx. 324 (1905) ? *Oligonema fulvum* Pav. & Lag. in Bull. Soc. Myc., Fr., xix. 99, pl. iv, fig. B (1903) (*non* Morgan).

Var. **inconspicua** Lister Mycetozoa, 169 (1894): elaters regular, cylindrical, spiral bands distinct, close and regular.—*T. inconspicua* Rost. Mon., l.c.; Mass. l.c., 180; Macbr. l.c., 268. *T. advenula* Mass. in Journ. R. Micr. Soc., 1889, 336; Mass. Mon., 181. *T. Andersoni* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 395. *T. Rostafinskii* Čel. fil. l.c., 37.

Var. **iowensis** Torr. in Broteria, vii. 55 (1908) (the State of Iowa). Elaters as in var. *inconspicua* but marked with scattered curved spines 6 to 10 μ long.—*T. iowensis* Macbr. in Bull. Nat. Hist. Iowa, ii. 133 (1892); N. Am. Slime-Moulds, ed. 2, 269.

Pl. 162.—*a*. sporangia; *b*. fragment of sporangium-wall, spores, and portions of two elaters, one with irregular spirals, the other, var. *inconspicua*, with regular spirals.

Intermediate forms connecting var. *inconspicua* with the typical form are of frequent occurrence, and the variations of capillitium described above have on several occasions been found represented in different sporangia of the same group. The sporangium-wall varies from yellow-brown, rosy brown to purplish-brown; occasionally it is whitish-lilac from deposits of angular crystals of lime, as in forms of some species of *Perichaena*. *T. reniformis* Peck has the granular thickening of the sporangium-wall and the rugged irregular spirals of typical *T. contorta*. A type specimen of *T. Andersoni* Rex from Sand Coulee, Montana, has most of the elaters with regular close spiral bands but in some they are rugged or even absent; the brown granules in the sporangium-wall are less abundant than is usual in *T. contorta*. The type of *T. advenula* Mass., from Glamis (K. 1748), is var. *inconspicua* of the present species. *T. heterotrichia* Balf., from Currey's collection (K. 1066), is an immature specimen of *T. contorta*; the sporangium-walls are almost free from granular deposits; the elaters are 4 to 5 μ diam., marked with one or three rugged or indistinct spiral bands, and scattered blunt spines; the spores adhere to one another, and are very faintly spinulose. The var. *iowensis* is merely a form with scattered spines on the elaters, and is hardly worthy of distinction. *T. pachyderma* Čel. fil. is a form of the present species with thick-walled elaters marked with faint spiral bands. *T. intermedia* Čel. fil. combines the characters of typical *T. contorta* and the var. *inconspicua*. *T. Rostafinskii* Čel. fil. is the var. *inconspicua*, with both sessile and shortly stalked sporangia. *T. ovalispora* Hollós, from Hungary, may possibly be a form of the present species; oval spores are met with occasionally in many species of the genus *Trichia*.

Forms of *T. contorta* having the elaters branched and combined into a network are so frequent that for convenience of reference they are placed in the genus *Hemitrichia* under the name *H. Karstenii* Rost. *T. contorta* var. *engadinensis* Meylan (Bull. Soc. Vaud. Sc. Nat., liii. 460 (1907)) is a form with very long elaters: var. *attenuata* Meylan (Ann. Cons. Genève (1913) 320) has elaters with ends more gradually tapering than usual.

Hab. On dead wood: both the typical form and var. *inconspicua* are frequent in the British Isles in autumn and winter, and are widely distributed throughout North Temperate regions.

8. **T. alpina** Meylan in Bull. Soc. Vaud. Sc. Nat., liii. 460 (1921). Plasmodium rich orange-red. Sporangia scattered or clustered, sessile, subglobose or forming long curved plasmodiocarps, 0·5 to 0·7 mm. diam., purple-black or black; sporangium-wall cartilaginous, of two layers, the inner translucent olive or yellow, the outer chestnut or olive-brown, thickened externally with granular deposits. Capillitium of bright yellow elaters, 4 to 6 μ wide, marked with two to six regular or rugged and sometimes spinose spiral bands, and with shortly tapering ends. Spores bright yellow in mass, globose or oval, minutely warted, 13 to 20 μ diam.—*T. contorta* var. *alpina* R. E. Fries in Arkiv Bot., vi. 5 (1906); Lister Mycetozoa, ed. 2, 213.

Pl. 162.—*c.* sporangia; *d.* fragment of sporangium-wall, elater, and spore.

This species is abundant and widely distributed in alpine and subalpine regions in Sweden, Switzerland, and Austria. It has been found also, developing from orange-red plasmodium, by the Rev. P. J. Alexander on decaying leaves of *Prunus Lauro-cerasus*, at Weybridge, Surrey, April 1922, showing that it is not an exclusively alpine form. The elaters sometimes form rings or loops and have either pointed or truncate ends.

Hab. On decaying leaves, herbaceous stems and twigs, usually in alpine regions.—Surrey, Sweden, Switzerland, Austria.

9. **T. lutescens** Lister in Journ. Bot., xxxv. 216 (1897) (yellowish). Plasmodium watery-pink. Sporangia sessile, scattered or in small clusters, globose or bolster-shaped, 0·15 to 0·7 mm. diam., shining bright yellow or olivaceous-yellow; sporangium-wall membranous, yellow, entirely free from granular deposits, often embossed with the impression of the underlying spores. Capillitium consisting of short or long, simple or branching pale yellow elaters, 3 to 4·5 μ diam., marked with four to five distinct or often faint spiral bands, either tapering or blunt and bulbous at the tips. Spores bright or olivaceous yellow, closely warted or spinulose, 10 to 12 μ diam.—Torrend Fl. Myx., 116. *Oligonema furcatum* Buckn. in Mass. Mon., 173 (1892). *Trichia contorta* var. *lutescens* Lister Mycetozoa, 169 (1894).

Pl. 161.—*c.* sporangia (Yorks); *d.* elaters and fragment of sporangium-wall; *e.* tip of elater and spores.

This species is allied to *T. contorta*, from which it is distinguished by the sporangium-wall being translucent and entirely free from granular deposits. An abnormal form was found by Dr. R. E. Fries near Upsala (B.M. 2915),

having yellowish-brown sporangia varying in size from 0·3 to 0·7 mm. diam.; some elaters are short and simple, others branch and anastomose, and show many spherical or irregular expansions and blunt spine-like processes. Similar forms were obtained by the Rev. P. J. Alexander on alder sticks in a ditch at Weybridge, Surrey, and here he observed the colour of the plasmodium for the first time. Among numerous gatherings of *T. lutescens* made by Dr. Torrend, near Lisbon, is one with long elaters combined to form a network; this has been placed by Dr. Torrend under *Hemitrichia Karstenii* as var. *lutescens* (Bull. Soc. Port. Sc. Nat., ii. 61 (1908)); while M. Meylan names it *Hemitrichia obrussea* (Bull. Soc. Vaud. Sc. Nat., lii. 449 (1919)); to give an entirely new name to what is clearly only an abnormal form of *T. lutescens* is not very helpful; in most species of *Trichia* such '*Hemitrichia* forms' are met with after inclement weather. Bucknall's earlier specific name is not here revived as the combination *Trichia furcata* was previously given by Wigand to what appears to be a small form of *T. decipiens*.

Hab. On dead wood, sticks, &c., also on living elm trunk (Rev. W. Cran).—Devon, Somerset, Worcestershire, Surrey, Norfolk, Yorkshire, Aberdeenshire; Norway, Sweden, Germany, Switzerland, Bohemia, Portugal.

10. **T. erecta** Rex in Proc. Acad. Nat. Sci. Phil., 1890, 193. Plasmodium white. Total height 1 to 2 mm. Sporangia scattered, stalked or nearly sessile, globose or turbinate, 0·5 to 0·7 mm. diam., bright yellow, mottled with well-defined dark brown, purplish-red or rosy-brown patches; sporangium-wall membranous, pale yellow, densely charged with brown granular matter in the dark patches. Stalk cylindrical, 0·1 to 1 mm. high, 0·2 to 0·3 mm. thick, dark brown, opaque. Capillitium of bright yellow or orange elaters, 3·5 to 4 μ diam., with short tapering ends, marked with four bands forming a close spiral, studded with few or many spines. Spores bright yellow or orange in mass, minutely warted, 11 to 13 μ diam.—Mass. Mon., 184; Macbr. N. Am. Slime-Moulds, ed. 2, 276.

Pl. 158.—*e*. sporangia; *f*. elater; *g*. spore (United States).

Prof. M. Brandza has found this species extremely abundant in some years in mountain woods of Moldavia; his observation that the plasmodium was white convinced him that the sporangia could not belong to any form of *T. Botrytis*, from which *T. erecta* differs also in the shortly tapering ends of the elater.

Hab. On dead wood.—Moldavia, Ceylon, Victoria and New South Wales, New Zealand, and the States of New York and Tennessee.

11. **T. decipiens** Macbr. N. Am. Slime-Moulds, 218 (1899) (deceiving). Plasmodium rose-coloured or white. Total height 1·5 to 3 mm. Sporangia stalked, rarely sessile, gregarious, turbinate, 0·6 to 0·8 mm. diam., shining olive or yellow-brown; sporangium-wall yellow, membranous, of two layers; the upper part of the wall often forms a cap of thinner texture which breaks up leaving a circular opening. Stalk cylindrical, furrowed, 0·1 to 1 mm. long, olive or dark

brown, filled to the base with spore-like cells. Capillitium of simple or branched smooth olive-brown elaters, 4·5 to 5·5 μ diam., marked with four or five spiral bands, 0·5 to 1 μ broad, gradually tapering into long slender points. Spores yellow-brown in mass, either minutely warted or very closely and often irregularly reticulated on one side, 9 to 12 μ diam.—*Arcyria decipiens* Pers. in Ust. Ann. Bot., xv. 35 (1795). *Mucor miniatus* Jacq. Fl. Austr., iii. 54, t. 299 (1775) ? *Sphaerocarpus piriformis* Bull. Champ., 129, t. 417, fig. 2 (1791) ? *Trichia fallax* Pers. Obs. Myc., i. 59 (1796) ; Rost. Mon., 243 ; Mass. Mon., 192 ; Lister Mycetozoa, 170. *T. virescens* Schum. Enum. Pl. Saell., ii. 208 (1803). *T. cerina* Ditm. in Sturm Deutsch. Fl., Pilze, ii. 51, t. 25 (1814). *T. fulva* Purt. Midl. Fl., iii. 290 (1821). *T. clavata* Wigand in Pringsh. Jahrb. Bot., iii. 28 (1863) ? *T. furcata* Wigand l.c., 29, t. 1, fig. 1 to 11. *T. nana* Zukal in Verh. Zool.-Bot. Gesell. Wien, xxxv. 334, t. xv, f. 8 (1886). *T. Stuhlmanni* Eichelb. in Verh. Nat. Ver. Hamb., ser. 3, xiv. 32 (1907).

Pl. 158.—*a*. sporangia ; *b*. elater ; *c*. spores (England) ; *d*. spore, reticulated on one side, spinulose on the other (United States).

The elaters vary in length in different gatherings ; usually they are long, sometimes they are short and somewhat fusiform (see R. E. Fries in Svensk Bot. Tidskr., iv. 261, fig. 3 (1910)) ; they are either simple or branched, but apparently never unite to form a *Hemitrichia*-like network. The warts on the spores may be scattered, and number either eight to ten in a line across the hemisphere, or are more crowded ; in some specimens the spores are minutely reticulated on one side, and spinulose on the other. The white and rose-coloured plasmodia have not been observed growing together on the same piece of wood, but the sporangia produced from both appear to be identical in every respect. The slender stalks filled with spore-like cells distinguish this species from *T. Botrytis*, its nearest ally. Almost sessile sporangia sometimes occur, but they are usually accompanied by others having well-formed stalks. Several varieties have been described, but they appear to represent forms rather than important varieties. The var. *olivacea* Meylan (Bull. Soc. Vaud. Sc. Nat., xliv. 299 (1908)) has shining sporangia with thin opaque caps that disappear leaving a clean circular opening : var. *gracilis* Meylan (l.c., xlvi. 53) has small sporangia on long slender stalks : var. *rubiformis* Meylan (Ann. Cons. Bot. Genève, 1913, 320) has almost sessile sporangia : forma *nodulosa* Brandza (Ann. Sc. Univ. Jassy, viii. 272 (1914)) has short much-branched elaters, marked with nodes from which branches spread in all directions : var. *hemitrichioides* Brandza (l.c.) has golden yellow sporangia containing yellow spores and elaters some of which are normal, while others are very long and twisted on themselves.

Hab. On dead wood : common throughout the year in the British Isles, and in all temperate regions ; fairly common also in Ceylon at high altitudes.

12. **T. Botrytis** Pers. in Roemer, N. Mag. Bot., i. 89 (1794) (*βότρυς* bunch of grapes). Plasmodium purple-brown. Total height 1·5 to 5 mm. Sporangia stalked, pyriform or turbinate, simple or combined in clusters, 0·6 to 0·8 mm. diam., yellowish-

olive, red-brown or purple, often veined with paler lines of dehiscence ; sporangium-wall of two layers, the outer charged with granular matter and continued into the stalk, the inner membranous, translucent, enclosing the spores. Stalks cylindrical, often combined in clusters of three to eight, furrowed, red- or purple-brown, consisting within of spongy tissue enclosing refuse-matter. Capillitium of cylindrical yellowish-brown elaters, 4 to 5 μ diam., sometimes branched, gradually tapering to long slender points which are smooth at the tips, marked with three to five flattened or prominent lax and often rugged spiral bands. Spores ochraceous-yellow, minutely spinulose, 9 to 11 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 274. *Stemonitis Botrytis* Pers. in Gmel. Syst. Nat., 1468 (1791). *Trichia serotina* Schrad. in Schrad. Journ. Bot., v. 67 (1799). *T. pyriformis* Fr. Syst. Myc., iii. 184 (1829) *non* Pers. ? *T. Lorinzeriana* Corda Icon., i. 23, f. 228 D (1837). *T. purpurascens* Nyl. in Saellsk. Faun. Fl. Fenn., iv. 126 (1859) ; Mass. Mon., 177. *T. fragilis* Rost. Mon., 246 (1875) ; Mass. l.c., 175. *T. Carlyleana* Mass. in Journ. R. Micr. Soc., 1889, 329 ; Mass. Mon., 174. *Sphaerocarpus fragilis* Sow. Engl. Fung., t. 279 (1803).

Var. **munda** Lister in Journ. Bot., xxxv. 216 (1897) (neat). Elaters pale brown or yellowish-brown, marked with close and regular spiral bands, with long tapering points ; spores yellow or brownish-yellow.

Var. **flavicoma** Lister Mycetozoa, 172 (1894) (yellow-haired). Sporangia minute, solitary, purplish-brown with yellow lines of dehiscence ; elaters and spores bright yellow.

Var. **cerifera** G. Lister in Journ. Bot., liii. 211 (1915) (wax-bearing). Sporangia red-brown spotted with patches of yellow wax.

Pl. 163.—*a*. sporangia (England) ; *b*. elater, var. *munda* ; *c*. elater of typical form ; *d*. spore ; *j*, *k*. sporangia and elater of var. *flavicoma*.

The sporangia of this abundant species may vary in colour in a single colony from nut-brown to rosy brown veined with yellow lines of dehiscence, or to almost uniform black. The varieties *munda* and *flavicoma* are well-marked and constant ; var. *cerifera* may possibly be a form resulting from weather conditions. *T. Carlyleana* Mass., from Carlisle, is the typical form with minutely spinulose spores perhaps more nearly smooth than usual. The type of *T. purpurascens* Nyl. from Finland, is the same form, and has dull purple sporangia ; the spores average 10 μ diam., and are minutely spinulose.

Hab. On dead wood : the typical form is common in the British Isles especially in autumn and winter ; it is widely distributed throughout Europe and also in the United States and Canada, but is not common there ; recorded also from Ceylon, Australia, and New Zealand : var. *munda* is fairly abundant in the British Isles, and has been recorded from Portugal, Austria, South Chili, and Washington Territory : var. *flavicoma*, on dead leaves of holly, rhododendron, &c. ; recorded from Devon, Dorset, Somerset, Hampshire, Wiltshire, Sussex, Surrey, Norfolk, Aberdeenshire, and Portugal ;

var. *cerifera* on dead wood ; recorded from Somerset, Dorset, Surrey, Kent, Bedfordshire, Derbyshire, Dumfriesshire, Aberdeenshire, New South Wales, and New Zealand.

13. **T. floriformis** G. Lister in Journ. Bot., lii. 110 (1919) (*flos* flower, *forma* shape). Plasmodium purple-brown. Sporangia stalked, free or usually adhering in clusters of two to twenty, obovoid or cylindrical, rosy brown often mottled with darker shades, purple-red or nearly black ; sporangium-wall as in *T. Botrytis*. Stalks furrowed, bright or dark red, translucent and free from refuse-matter, 1 to 2 mm. or more long, usually adhering in clusters and arising from a red hypothallus. Capillitium of pale brownish-red elaters, marked with four to six spiral bands, ending in tapering points from 20 to 40 μ long. Spores brick-red in mass, pale orange-red by transmitted light, minutely warted, 10 to 11 μ diam.—*Craterium floriforme* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 258 (1832). *Lycoperdon bombacinum* Batsch Elench. Fung., 153 (1783) ? *T. lateritia* Lév. in Ann. Sci. Nat., ser. 3, v. 167 (1846) ; Rost. Mon., 250 ; G. Lister in Journ. Bot., liii. 211 ; Macbr. N. Am. Slime-Moulds, ed. 2, 277. *T. Decaisneana* de Bary in Rost. Mon. l.c. *T. Botrytis* var. *lateritia* Lister Mycetozoa, ed. 2, 217 (1911).

Pl. 163.—*e.* sporangia ; *f*, *g*, *h.* elaters ; *i.* spore.

Dr. W. C. Sturgis, having examined the type of *Craterium floriforme* in the Schweinitzian Herbarium, finds that it is undoubtedly the present species which has long been known under the specific or varietal name '*lateritia*'. *T. floriformis* is closely allied to *T. Botrytis*, from which it differs in the brick-red colour of the spores, and in the stalks being translucent when seen by transmitted light, and not enclosing refuse-matter ; sometimes, however, a little refuse-matter or small masses of spore-like cells occur within the folds of the stalk near the base. It seems possible that Fries had this abundant and widely distributed species in mind when describing *T. pyriformis* G. F. Hoffm. (see Syst. Myc., iii. 184), but Hoffmann's original description and figure (Veg. Crypt., ii. 1, t. 1, fig. 1 (1790)) unquestionably refer to *Hemitrichia Vesparium*, a species which in the field bears a close resemblance to *T. floriformis*.

Hab. On decayed wood, especially of coniferous trees : not common but widely distributed in the British Isles : widely distributed in all temperate regions ; recorded also from Ceylon.

14. **T. subfusca** Rex in Proc. Acad. Nat. Sci. Phil., 1890, 192 (somewhat dark). Plasmodium ? Sporangia stalked, gregarious, solitary or united in pairs, subglobose or pyriform, 0·5 to 0·9 mm. diam., dull brown, yellowish- or reddish-brown ; sporangium-wall membranous with more or less evenly distributed dark granular deposits. Stalk brown or purple-brown, stout and furrowed, separated from the cavity of the sporangium by the inner layer of the sporangium-wall. Capillitium consisting of bright yellow elaters, 4 to 6 μ wide, marked with three to four prominent spiral bands, ending in

short slender often curved tips. Spores yellow, minutely spinulose, 11 to 13 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 275. *T. Botrytis* var. *subfusca* Lister Mycetozoa, 172.

Pl. 163.—*l.* sporangium ; *m.* elater ; *n.* spore (Adirondack Mountains, New York).

This species is closely allied to *T. Botrytis*, from which it is distinguished by the yellow elaters having short, not long and tapering ends.

Hab. On dead wood : recorded from Sweden, the Jura Mountains ?, Ceylon, and the States of New York and Washington.

Genus 42.—**OLIGONEMA** Rostafinski Mon., 291 (1875) (ὀλίγος few, νῆμα thread). Sporangia minute, densely clustered or heaped ; capillitium usually scanty, of short or long threads, with spiral markings obscure or wanting ; spores reticulated.

KEY TO THE SPECIES OF *OLIGONEMA*.

Sporangium-wall smooth ; spores irregularly reticulated. 1. *O. nitens*

Sporangium-wall with minute granular thickenings ; spores regularly reticulated. 2. *O. flavidum*

1. **O. nitens** Rost. l.c., f. 198 (shining). Plasmodium watery-white. Sporangia subglobose, sessile, heaped together for the most part in large clusters, 0·2 to 0·4 mm. diam., shining yellow or olivaceous-yellow ; sporangium-wall membranous, yellow, smooth except for scattered curved thickenings enclosing a thinner membrane. Capillitium usually of short, cylindrical simple branched or ring-shaped yellow elaters, 3 to 5 μ diam., with rounded or abruptly pointed ends, either smooth or marked with one to four irregular and indistinct sinistral spiral bands passing from the right above to the left below when the thread is viewed horizontally, occasionally marked with ring-shaped thickenings and scattered spines. Spores yellow, 11 to 16 μ diam., reticulated with broad and pitted bands, or with narrow bands forming an irregular net, border 0·5 to 1·5 μ wide.—Mass. Mon., 170 ; Macbr. N. Am. Slime-Moulds, ed. 2, 280. *Trichia nitens* Libert Pl. Crypt. Ard., Fasc. iii, no. 277 (1834) (*non* Pers.). *T. bavarica* de Thuemen Myc. Univ., no. 1497 (1879). *T. Kickxii* Rost. l.c., App. 40 (1876). *T. pusilla* Schroet. in Cohn Krypt. Fl. Schles., iii. 1, 114 (1885). *Physarum Schweinitzii* Berk. in Grev., ii. 66 (1873). *Cornuvia nitens* Rost. Versuch, 15 (1873). *Oligonema bavaricum* Balf. & Berl., in Sacc. Syll., vii. 437 (1888).

Pl. 164.—*d.* sporangia ; *e.* elaters ; *f.* spore (Ardennes ; Mme. Libert's type).

This species varies in the markings on the elaters and the reticulation of the spores, and great variety is often seen in a single sporangium ; the length of the elaters in some specimens is only about 50 μ, while others are very much longer. *O. nitens* is allied to *Trichia affinis*, in which species

similar variations in spores and elaters are sometimes found in sporangia which have been exposed to unusual conditions of development. A variety appeared in the Botanic Gardens at Leipsic (B.M. 2960, ex Herb. Čelakovsky) in which many of the elaters branch and anastomose while others remain free; the threads are expanded into irregular vesicles at the axils of the branches, and are marked with ring-shaped thickenings and about four faint spiral bands. *O. bavaricum* Balf. & Berl. is described as differing from the present species in the more distinct spirals on the elaters, but the spirals are quite as distinct in Libert's type; the spores of the Bavarian gathering vary in size from 12 to 16 μ, and the reticulation also varies so as to present from four to sixteen meshes on the surface of the hemisphere. The type specimen of *Physarum Schweinitzii* Berk., from Bethlehem, U.S.A. (K. 1738), is typical *O. nitens*. The descriptions of *Trichia Kickxii* Rost. and *T. pusilla* Schroet. agree so perfectly with the characters of *O. nitens* that they are here placed as synonyms of this species.

Hab. On old tan, dead wood, sticks, &c., especially on those periodically submerged in ditches: recorded from Cornwall, Sussex, Surrey, Staffordshire, Salop, Yorks, Cumberland, Belgium, Germany, Switzerland, Bohemia; widely distributed in the United States and Canada.

2. **O. flavidum** Peck in Rep. N. York Mus., xxxi. 42 (1879) (golden yellow). Plasmodium watery-white? Sporangia crowded, heaped and scattered, ovoid or subglobose, 0·3 to 0·6 mm. diam., shining yellow; sporangium-wall membranous, translucent yellow, marked with a close reticulation or with minute close-set thickenings arranged in wavy or fan-like lines, which give the effect of delicate stippling. Capillitium scanty or fairly abundant, of short or long, simple or branched threads, varying from 3 to 5 μ diam., often showing irregular swellings, without distinct spiral bands, but marked with close lines of minute warts that usually form irregular dextral spirals passing from the left above to the right below when the thread is viewed horizontally—that is in the reverse direction to the spirals of *Trichia* elaters. Spores yellow, 12 to 13 μ diam., regularly reticulated with narrow bands, which give a border of 1 μ, and form a net showing three to five meshes across the hemisphere.—Mass. Mon., 171; Macbr. N. Am. Slime-Moulds, ed. 2, 279; Lister in Journ. Bot., xlii. 137; Torrend Fl. Myx., 119. *Perichaena flavida* Peck l.c., xxvi. 76 (1874). *O. brevifilum* Peck l.c., xxxi. 42 (1879); Macbr. l.c., 280. *O. minutulum* Mass. in Journ. R. Micr. Soc., 1889, 348. *O. nitens* Lister Mycetozoa, 173 (1894), in part.

Pl. 165.—*a*. sporangia; *b*. elaters and spores with fragment of sporangium-wall; *c*. part of elater, and two spores (Sussex).

This species is nearly allied to the preceding, and is distinguished by the granular thickenings of the sporangium-wall, the minutely warted capillitium and by the regular reticulation of the spores. Among the numerous gatherings made by Mr. Hugo Bilgram in Fairmount Park, Philadelphia, is one (B.M. 2966) having the capillitium threads long and repeatedly branched and anastomosing; the spore-net is closer than usual, showing about five meshes across the hemisphere. This gathering serves to prove how close is the connexion between *O. flavidum* and *Calonema aureum*.

The type of *O. brevifilum* Peck appears to differ from that of *O. flavidum* only in having fewer and shorter elaters. An unusual form with dull ochraceous sporangia scattered over decaying leaves was found by Mrs. J. Drake at Serampore near Calcutta in September 1918 : the sporangium-walls are pale buff and are thickened with granular deposits of yellowish-brown refuse-matter ; the yellow spores are beautifully reticulated as in typical *O. flavidum* ; no capillitium is developed in the sporangium examined.*

Hab. On dead wood, sticks and leaves, in ditches and by ponds.—Sussex, Salop, North Germany, Portugal, and North Africa ; widely distributed in the United States ; recorded also from Ontario.

Genus 43.—**CALONEMA** Morgan in Journ. Cinc. Soc. Nat. Hist., xvi. 27 (1893) (καλός beautiful, νῆμα thread). Resembling *Oligonema*, except that the threads of the capillitium are combined to form a network.

1. **C. aureum** Morgan l.c. (golden). Plasmodium ? Sporangia sessile, clustered, subglobose, 0·3 to 0·6 mm. diam., shining yellow ; sporangium-wall membranous, yellow, translucent, marked with delicate branched lines of thickening forming an irregular net resembling fan-tracery with thinner spots whence the lines of tracery radiate. Capillitium consisting of branching yellow threads, 3 to 5 μ diam., more or less united to form a network, and marked with raised lines, or rows of minute warts, arranged to form either an irregular reticulation or spirals like those on the elaters of *Oligonema flavidum*, or with incomplete ' *Trichia* ' spirals ; ring-shaped thickenings and scattered spines usually present. Spores yellow, 13 to 15 μ diam., regularly reticulated with narrow raised bands, which give a border of 1 to 1·5 μ to the margin, and form a net showing five to six meshes across the hemisphere.—Macbr. N. Am. Slime-Moulds, ed. 2, 266. *Oligonema flavidum* var., Lister in Journ. Bot., xlii. 138 (1904).

Pl. 165.—*d.* sporangia ; *e.* capillitium and fragment of sporangium-wall ; *f.* capillitium and two spores (Ohio).

This species has been found repeatedly, maintaining its distinctive characters, in various States of North America. It is closely allied to *Oligonema flavidum*, with which it is connected by intermediate forms, and of which it appears to be hardly more than a variety. Morgan's genus *Calonema* is here retained for convenience of classification.

Hab. On dead wood.—South Carolina, Maryland, Illinois, Alabama, Ohio, Minnesota.

Genus 44.—**HEMITRICHIA** Rostafinski Versuch, 14 (1873) (ἡμι- half, and *Trichia*). Sporangia stalked or sessile ; capillitium a more or less elastic network of branching threads, thickened with two to six spiral bands ; spores minutely warted or reticulated. *HEMIARCYRIA* Rost. Mon., 261 (1875).

* Further specimens show this to be *Cornuvia Serpula*.

KEY TO THE SPECIES OF *HEMITRICHIA*.

A. Spores nearly smooth or minutely warted :—

a. Capillitium red, spinose. 1. *H. Vesparium*

b. Capillitium yellow, yellow-brown or yellow-grey—

α. Sporangia usually stalked—

Stalk solid ; sporangia orange ; capillitium spinose, with distinct spiral markings. 2. *H. intorta*

Stalk solid ; sporangia olive-yellow ; capillitium smooth, spiral markings often faint. 3. *H. leiotricha*

Stalk solid or absent ; sporangia minute, buff ; capillitium smooth or spinose, spiral markings faint. 4. *H. minor*

Stalk hollow, filled with spore-like cells—

Cup papillose. 5. *H. clavata*

Cup smooth. 6. *H. leiocarpa*

β. Sporangia usually sessile—

Spirals of capillitium one to three, prominent ; sporangium-wall translucent. 7. *H. abietina*

Spirals of capillitium three or more, often indistinct ; sporangium-wall thickened with granular deposits. 8. *H. Karstenii*

B. Spores reticulated :—

Capillitium threads spinose. 9. *H. Serpula*

Capillitium threads smooth. 10. *H. chrysospora*

1. **H. Vesparium** Macbr. N. Am. Slime-Moulds, 203 (1899) (wasp's nest). Plasmodium purple-red. Total height 1·3 to 2·5 mm. Sporangia clavate or sub-cylindrical, stalked or sessile, combined in clusters or crowded, 1 to 1·3 mm. high, 0·5 to 0·7 mm. broad, glossy or shining, dark red, red-brown, or olive-black ; sporangium-wall of two layers, the outer continued into the stalk, the inner enclosing the spores, orange-red. Stalks membranous, 0·2 to 1 mm. high, usually combined in clusters of from six to twelve, furrowed and rugose, red, not enclosing spore-like cells. Capillitium red or orange-red in mass, consisting of twisting sparingly branched orange-red threads 5 to 6 μ diam., with few pointed free ends, marked with three to five regular spiral bands, and studded with numerous scattered spines 2 to 5 μ long, rarely nearly smooth. Spores pale orange-red, warted, 10 to 11 μ diam.—*Lycoperdon Vesparium* Batsch Elench. Fung., 253, fig. 172 (1786). *Stemonitis cinnabarina* Roth Fl. Germ., 547 (1788) ? *Trichia pyriformis* Hoffm. Veg. Crypt., ii. 1, t. 1, fig. 1 (1790).

T. rubiformis Pers. in Roemer N. Mag. Bot., i. 89 (1794); Fr. Syst. Myc., iii. 183. *T. fragiformis* Wither. Br. Pl., ed. 2, iii. 480 (1792). *T. chalybea* Chev. Fl. Paris, i. 323 (1826). *T. Neesiana* Corda Icon., i. 23 (1837). *T. Ayresii* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 2, v. 367 (1850). *Stemonitis Vesparia* Gmel. Syst. Nat., 1470 (1791). *Craterium porphyrium* Schw. l.c. *Hemiarcyria rubiformis* Rost. Mon., 262 (1875). *Arcyria rubiformis* Mass. Mon., 158 (1892). *Hemitrichia rubiformis* Lister Mycetozoa, 175 (1894).

Pl. 166.—*a*. cluster of sporangia; *b*. capillitium and spores with fragment of sporangium-wall; *c*. capillitium and spore (England).

Sporangia are occasionally found with a few free elaters pointed at each end in addition to the continuous network of threads of the usual type.

Hab. On dead wood: not uncommon in the British Isles, and recorded from most temperate and tropical regions; abundant in the United States.

2. **H. intorta** Lister Mycetozoa, 176 (1894) (twisted). Plasmodium watery-white. Total height 1 to 1·5 mm. Sporangia stalked, gregarious or scattered, turbinate, 0·3 to 0·7 mm. diam., shining orange-yellow; sporangium-wall membranous above, thickened with granular deposits towards the base, papillose on the inner side. Stalk thickened above and below, furrowed, 0·5 to 0·7 mm. long, 0·15 mm. thick in the middle, glossy purplish-brown, opaque. Capillitium a twisted tangle of sparingly branched orange-yellow threads, 4 μ diam., marked with four to five closely set spiral bands sometimes connected with longitudinal striae, densely spinulose. Spores yellow, minutely warted, 9 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 264. *Hemiarcyria intorta* Lister in Journ. Bot., xxix. 268, tab. 312, fig. 3 (1891). *H. longifila* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 396.

Pl. 172.—*a*. sporangia; *b*. capillitium and spores (England).

This species appeared in considerable abundance on an old elm log, near Hitchin, Herts, in March 1889, and January 1890, and was described in the *Journal of Botany*, l.c. A few months later it was independently recorded by Dr. Rex l.c., under the name of *H. longifila*. Specimens received from America are similar to the English gatherings.

Hab. On dead wood.—Hertfordshire, Staffordshire, Yorkshire; Pennsylvania, Ohio, Iowa.

3. **H. leiotricha** Lister Mycetozoa, ed. 2, 224 (1911) (λεῖος smooth, θρίξ thread). Plasmodium watery-white. Sporangia stalked, rarely sessile, scattered, subglobose, 0·5 to 0·9 mm. diam., shining dull yellow or olivaceous; sporangium-wall usually of two layers, the outer composed of scattered deposits of dark brown refuse-matter, the inner translucent, marked with scattered ring-shaped or crescentic thickenings. Stalk dark brown or black, stout, 0·1 to 0·3 mm. high. Capillitium a twisted tangle of sparingly branched smooth yellow threads, 3 to 4 μ wide, with few or many rounded or pointed free ends,

marked with 3 to 6 often faint spiral bands. Spores yellow or olivaceous, minutely warted, 9 to 13 μ diam.—*H. intorta* var. *leiotricha* Lister Mycetozoa, 176 (1894); R. E. Fries in Arkiv. Bot., iv. no. 7, 5; Petch in Ann. Perad., iv. 363?

Pl. 172.—*c.* sporangia; *d.* capillitium and spores (England).

In this species the capillitium may vary considerably in a single group of sporangia, consisting either of long free elaters, or of the typical *Hemitrichia* network. In a cold weather development obtained by the late W. B. Allen on bramble stems near Broseley, Salop (B.M. 2982), some of the nearly sessile sporangia have normal yellow capillitium, while in others it consists of both short and long, simple or branching threads which are almost colourless, 2 μ wide, without spiral markings, and provided with many broad ring-like thickenings. In a puzzling specimen from Mr. Petch on the leaf of a Talipot palm (*Corypha*) in Ceylon (B.M. 2985), the sporangia were rose-pink when immature, and are nearly or quite sessile; the capillitium differs from typical *H. intorta* in being marked with five to six close spiral bands, and the sporangium-wall has scanty deposits of refuse-matter. A single sporangium found on a chip of spruce wood, Arosa, Graubunden, August 1913, is remarkable in having all the spirals of the capillitium dextral instead of sinistral.

Hab. On dead leaves, sticks, &c.: not uncommon in Britain from autumn to spring: recorded from Devon, Dorset, Worcestershire, Salop, Surrey, Bedfordshire, Hertfordshire, Essex, Northumberland, Wales, Aberdeenshire; Norway, Sweden, North Germany, Switzerland.

4. **H. minor** G. Lister in Journ. Bot., xlix. 62 (1911) (less). Plasmodium watery-cinnamon. Sporangia stalked or sessile, scattered or united in pairs, subglobose or forming curved plasmodiocarps, 0·2 to 0·4 mm. diam., glossy, pale yellowish-buff; sporangium-wall membranous, pale yellow, minutely papillose or marked with faint curved lines of thickening, and having scanty superficial deposits of refuse-matter. Stalk black, cylindrical, enclosing dark refuse matter, 0·1 to 0·2 mm. high. Capillitium a loose network of flaccid yellowish threads 3 to 4 μ diam., with few or many free ends, marked with three or four faint sinistral spiral bands, either almost smooth or rather closely studded with slender spines 1 to 4 μ long, often showing ovoid vesicular expansions. Spores pale yellow, closely and minutely warted, 9 to 10 μ diam.

Var. **pardina** Minakata in litt. ex G. Lister in Trans. Br. Myc. Soc., v. 82 (1914), pl. 1, figs. 3, 3 *a–c* (from *pardus* leopard). Sporangia and plasmodiocarps buff, thickly spotted with prominent blackish-brown warts composed of refuse-matter; spirals of capillitium usually dextral.

Pl. 187.—*d.* sporangia; *e.* capillitium; *f.* capillitium and spore with fragment of sporangium-wall (Japan).

This minute and inconspicuous species has been gathered many times on the bark of fallen branches and of living trees by Mr. K. Minakata, in the province of Kii, Japan; it has been found repeatedly on living tree-trunks in Somerset by Mr. N. G. Hadden, in Norfolk by Mr. H. J. Howard, and in Aberdeenshire by the Rev. W. Cran. It somewhat resembles *Perichaena vermicularis* Rost., but differs in the capillitium being marked with

spiral bands; the threads vary in roughness in the different gatherings; in one specimen they are almost smooth, in another they are closely marked with warts and short spines, while in a third they are studded with both short and long spines. Sometimes the course of the threads is interrupted by a series of large vesicular swellings containing oily matter. The var. *pardina* has a remarkable appearance, and, although it is connected with the typical form by intermediate gatherings, it seems worthy of varietal distinction.

Hab. On bark of dead and living trees, and on moss and dead leaves.—Somerset, Norfolk, Aberdeenshire, Japan: var. *pardina* recorded from Somerset, Dorset, Surrey, Aberdeenshire, and Japan.

5. **H. clavata** Rost. Versuch, 14 (1873) (*clava* club). Plasmodium watery-white or rose-red. Total height 1 to 3 mm. Sporangia stalked, gregarious or crowded, clavate or turbinate, 0·7 to 1·5 mm. high, shining ochraceous or olivaceous-yellow, globose and nearly sessile in irregular developments; sporangium-wall membranous, minutely papillose on the inner side, rarely reticulated, yellow, evanescent above, persistent below to form a more or less definite cup. Stalk cylindrical, 0·1 to 1·5 mm. long, furrowed or nearly even, olive, red-brown, or nearly black, filled with spore-like cells. Capillitium a network of yellowish-olive branched threads 5 to 6 μ diam., with or without rounded free ends, marked with five to six well-defined close or lax spiral bands 1 μ wide, usually velvety in profile, sometimes spinose in imperfect developments. Spores ochraceous, minutely warted, 8 to 10 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 264. *Trichia clavata* Pers. in Roemer N. Mag. Bot., i. 90 (1794). *T. citrina* Schum. Enum. Pl. Saell., ii. 209 (1803)? *T. obtusa* Wigand in Pringsh. Jahrb. Wissensch. Bot., iii. 30, t. 2, f. 4 (1863). *Arcyria decipiens* Berk. in Ann. Mag. Nat. Hist., ser. 1, ix. 447 (1842). *A. clavata* Mass. Mon., 165 (1892). *A. calyculata* Mass. l.c., 162. *A. stipitata* Mass. l.c., 163. *A. leocarpoides* Mass. l.c., 167. *Hemiarcyria clavata* Rost. Mon., 264 (1875). *H. calyculata* Speg. in Ann. Soc. Cient. Argent., x. 152 (1880). *H. stipitata* Mass. in Journ. R. Micr. Soc., 1889, 354. *H. Varneyi* Rex in Proc. Acad. N. Sc. Phil., 1891, 396. *H. ablata* Morgan in Journ. Cinc. Soc. Nat. Hist., xvi. 24 (1893). *H. funalis* Morg. l.c., 32. *H. plumosa* Morg. l.c., 29. *Cornuvia leocarpoides* Speg. l.c., xii. 256 (1881). *Hemitrichia stipitata* Macbr. l.c., 265. *H. montana* Morgan l.c., xviii. 40 (1895); Macbr. l.c., 266. *H. clavata* var. *montana* Meylan in Bull. Soc. Vaud. Sc. Nat., liii. 461 (1921).

Pl. 167.—*a*. sporangia; *b*. capillitium; *c*. spores (England); *d*. sporangia developed in cold weather (Philadelphia); *e*. capillitium of same showing spines, appearing among threads of the usual form, also fragment of sporangium-wall; *f*. sporangium with expanded capillitium.

This abundant and widely distributed species, although remarkably constant in its main characters, is subject to some variation depending on climate, the season of the year, and on altitude. The late Dr. Rex wrote

(Bot. Gaz., xv. 315): '*Hemiarcyria clavata* developed in the hot days of July and August will erect quickly into scattered, globose, long-stiped sporangia which rupture immediately as they dry, leaving scarcely a vestige of a receptacle, while the same species late in October will develop closely aggregated, obovate, almost clavate sporangia, nearly sessile or with quite short stipes, which rupture slowly several days after maturity, leaving a very deep funnel-shaped receptacle.' The presence of free ends to the capillitium-threads is not an unusual character, although in the most perfect developments they are usually absent. A gathering made by Dr. Sturgis in the Adirondack Mountains, New York, in September 1901, shows many free ends amongst the tangle of capillitium and also a number of short free elaters. A specimen of *H. montana* Morgan from the San Bernadino Mountains, California, at an altitude of 7,400 ft. is an irregular stunted form of the present species; the sporangia are shortly stalked or sessile, the capillitium is much branched and has many free ends, in some parts the spirals are regular, in others they are loose and rugged; the sporangium-wall is not papillose as in normal growths, but is marked with a delicate network resembling fan-tracery; similar markings associated with papillae appear in a specimen from Chili gathered by Prof. Thaxter (B.M. slide). The type of *Arcyria stipitata* Mass. from Java is a perfectly formed long-stalked specimen of *H. clavata*, with no free ends to the capillitium. The type of *Arcyria decipiens* Berk., collected by Charles Darwin at Rio Janeiro (K. 1766), is also a typical form of the present species.

Hab. On dead wood: frequent in the British Isles in autumn and winter; widely distributed and apparently common in all temperate and tropical regions.

6. **H. leiocarpa** Lister Mycetozoa, 177 (1894) (λεῖος smooth, καρπός fruit). Plasmodium ? Total height 1·5 mm. Sporangia scattered, stalked, obovoid, rarely subglobose, pale grey or ochraceous-grey, 0·7 mm. diam.; sporangium-wall evanescent above, persistent below as a cup, smooth or marked on the inside with short scattered ridges forming a broken reticulation, colourless, longitudinally plicate, minutely wrinkled transversely. Stalk 0·7 to 1 mm. long, 0·05 mm. thick, furrowed, ochraceous-grey, containing spore-like cells. Capillitium a network of frequently branching, pale grey threads, 2 to 5 μ thick, marked with three to five often prominent dextral spiral bands, either smooth, or studded in many parts with numerous spines about 2 μ long; free ends subclavate, usually spinulose. Spores smooth, pale grey in mass, 6 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 263. *Hemiarcyria leiocarpa* Cooke in Ann. Lyc. Nat. Hist. N. York, xi. 405 (1877), and Myx. Brit., 88, figs. 252, 255. *Lachnobolus Rostafinskii* Racib. in Rozpr. Mat. Przyr. Ak. Krak., xii. 80 (1884).

Pl. 168.—*a*. sporangia; *b*. capillitium and spore with fragment of sporangium-wall (Potts Point, Harpsell, Maine, U.S.A.).

This species outwardly resembles a slender form of *Arcyria cinerea*. The capillitium differs from that of most species of *Hemitrichia* in having dextral spiral bands, that is, they wind in a direction the reverse of what is usual in *Trichia* elaters. This feature is well marked in the type from

Potts Point, Maine, in a specimen obtained by Mr. H. Bilgram near Philadelphia in 1914, and in a growth which appeared on Sphagnum in a glass-house in the Botanic Gardens, Edinburgh; it is probably also present in the type of *Lachnobolus Rostafinski*, a mounting of which was lent us many years ago; but the direction of the spirals was not properly noted in a drawing made at the time. The type of *H. Varneyi* Rex, from Kansas, which was included under the present species in the previous editions of this book, has sinistral spirals on the elaters, and is probably a weak form of *H. clavata*.

Hab. On decayed wood, and moss.—Edinburgh (glass-house), Bohemia, Maine, Pennsylvania.

7. **H. abietina** Lister Mycetozoa, ed. 2, 227 (1911) (*abies* fir tree). Plasmodium rose-red. Sporangia crowded or gregarious, shortly stalked or sessile, subglobose or turbinate, rarely shortly cylindrical, 0·3 to 0·7 mm., opaque or shining, yellow, ochraceous, or apricot-coloured; sporangium-wall membranous, yellow, almost smooth, usually evanescent above and forming a persistent cup below. Stalks slender, ochraceous, 0·1 to 0·3 mm. long, filled with spore-like cells. Capillitium a tangle of flaccid, sparingly branched, ochraceous-yellow threads, 3 to 5 μ diam., marked with one to three slender prominent bands forming an irregular loose spiral, with few rounded or bulbous free ends. Spores yellow, minutely warted, 9 to 12 μ diam.—*Trichia abietina* Wigand in Pringsh. Jahrb. Bot., iii. 33, t. ii, fig. 11 (1863). *T. nana* Mass. in Journ. R. Micr. Soc., 1889, 336; Mass. Mon., 181. *Hemiarcyria Wigandii* Rost. Mon., 267 (1875). *Arcyria Wigandii* Mass. l.c., 163 (1892). *Hemitrichia ovata* Macbr. N. Am. Slime-Moulds, ed. 2, 261.

Pl. 168.—*c.* sporangia; *d.* capillitium and spore (Germany); *e.* sporangia (United States).

This species somewhat resembles the occasional *Hemitrichia* forms of *Trichia varia*, but is distinguished by the stalks when present being filled with spore-like cells, by the often well defined cup-like base of the sporangium-wall, and by the flaccid capillitium marked with slender spiral bands which are not more prominent on one side of the thread. The type of *Trichia nana* Mass. from Westbrook, Maine (K. 1164) is a sessile form of *H. abietina*. Rostafinski refers to having seen a specimen of this species in Persoon's herbarium named *Trichia ovata*, but he did not adopt that name as there were many other specimens in that collection named *Trichia ovata* which were species of *Trichia*. M. Meylan has published two varieties of the present species which appear to differ little from the typical form, var. *lutea*, and var. *aurantiaca*, described as being yellow and orange respectively (Bull. Soc. Vaud. Sc. Nat., xliv. 53 (1910)).

Hab. On dead wood or on the trunks of living trees: not common; recorded from Cornwall, Devon, Hampshire, Surrey; Norway, Sweden, France, Germany, Bohemia, Switzerland, Portugal, Japan, Ontario, New England, Ohio, and Colorado.

8. **H. Karstenii** Lister Mycetozoa, 178 (1894) (P. A. Karsten, a Finnish botanist, 1834 to 1917). Plasmodium watery-white.

Sporangia sessile, scattered, subglobose or forming elongated curved plasmodiocarps, 0·25 to 0·5 mm. broad, pale yellowish-brown, red- or purplish-brown; sporangium-wall of two layers, membranous or cartilaginous, the outer layer thickened with deposits of granular matter. Capillitium a loose network of branching yellowish or reddish-brown threads, 3 to 5 μ diam., marked with three to five more or less distinct spiral bands, rarely smooth, often with scattered ring-shaped thickenings and irregular expansions; free ends pointed or blunt. Spores yellow, minutely warted, 9 to 15 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 261; Torrend Fl. Myx., 105. *Hemiarcyria Karstenii* Rost. Mon., App. 41 (1876). *H. paradoxa* Mass. in Journ. R. Micr. Soc., 1889, 356. *H. obscura* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 395. *Arcyria Karsteni* Mass. Mon., 168 (1892). *A. paradoxa* Mass. l.c., 160. *Perichaena cornuvioides* Čel. fil. Myx. Böhm., 26, pl. i, figs. 6, 7 (1893).

Pl. 171.—*a*. plasmodiocarp; *b*. capillitium and spores with fragment of sporangium-wall; *c*. capillitium; *d*. spore.

H. Karstenii appears to be a *Hemitrichia* form of *Trichia contorta*, and its frequent occurrence is the only excuse for giving it specific rank as a *Hemitrichia*; it presents the same variety in the shape and colour of the sporangia, and in the markings and colour of the capillitium. Rostafinski's type from Ceylon (K. 1773) has pale yellow-brown sporangia, and rugged capillitium with faint spirals and many large rounded expansions; the spores are yellow, minutely warted, and measure 10 to 11 μ diam. Specimens from near Dudley, found by A. Camm, have both globose and bolster-shaped purple-brown sporangia and orange-brown capillitium, strongly contrasting with the yellow spores. The type of *Arcyria paradoxa* Mass., from Weybridge (K. 132), closely resembles the Ceylon gathering of *H. Karstenii*, only differing in the more regular, less branched capillitium, with fewer expansions; it is therefore included under the present species. The type of *Hemiarcyria obscura* Rex, from Montana, U.S.A. (B.M. slide), shows a dull yellowish-red capillitium; the threads are 2·5 to 3 μ diam., and are marked with close faint spirals; the spores are similar to those of the type of *H. Karstenii* at Kew, and there appears to be no specific character by which to separate *H. obscura* from this species. The type of *Perichaena cornuvioides* Čel. fil. from Bohemia appears to be an abnormal form of *H. Karstenii*, in which the capillitium shows no trace of spirals, and is marked with many small bladder-like or cup-shaped expansions; a somewhat similar specimen has been gathered near Birmingham, but having part of the capillitium marked also with distinct spiral bands. Such a form may closely resemble *Perichaena corticalis*.

Hab. On dead wood: widely distributed in Britain and Europe; recorded also from Ceylon, Japan, and the States of Colorado, Montana, and Washington.

9. **H. Serpula** Rost. Versuch, 14 (1873) (a genus of marine worms with coiled shells). Plasmodium yellow (*fide* Macbride). Sporangia forming elongated winding branched plasmodiocarps, 0·4 to 0·6 mm. wide, usually uniting into a close net, golden-yellow or brownish-yellow, often seated on a red-

brown hypothallus ; sporangium-wall of two layers, the outer membranous or cartilaginous, yellow, or brownish-yellow from deposits of refuse-matter, the inner membranous, delicately reticulated with a network resembling fan-tracery. Capillitium an elastic tangle of twisting sparingly branched yellow or orange threads, 5 to 6 μ diam., marked with three to four, rarely five to six, well-defined regular spiral bands, spinose, rarely smooth ; longitudinal striae often distinct ; free ends pointed. Spores yellow, reticulated with narrow bands forming a net with from nine to twelve meshes to the hemisphere, 10 to 12 μ diam. ; border 0·5 to 1 μ wide.—Macbr. N. Am. Slime-Moulds, ed. 2, 260 ; Petch in Ann. Perad., iv. 364. *Mucor Serpula* Scop. Fl. Carn., ed. 2, ii. 493 (1772). *Lycoperdon lumbricale* Batsch Elench. Fung., Cont. i. 259, t. 30, fig. 174 (1786). *Trichia spongioides* Vill. Pl. Dauph., 1061 (1789). *T. Serpula* Pers. in Roemer N. Mag. Bot., i. 90 (1794). *T. reticulata* Pers. l.c. *T. venosa* Schum. Enum. Pl. Saell., ii. 207 (1803). *Stemonitis lumbricalis* Gmel. Syst. Nat., 1470 (1791). *Hemiarcyria Serpula* Rost. Mon., 266 (1875). *Arcyria Serpula* Mass. Mon., 164 (1892).

Pl. 170.—*a*. plasmodiocarp ; *b*. spore and spinose capillitium with fragment of double sporangium-wall (Botanic Gardens, Glasgow) ; *c*. spore and smooth capillitium (Ceylon).

This handsome species is widely distributed but has not yet been recorded in the open air in Britain. Prof. Brandza describes it as occurring almost everywhere under bark in the forests of Moldavia. Mr. Petch writes that it is common in Ceylon, where 'the netted plasmodiocarps sometimes extend over an area 4 or 5 cm. long and 2 or 3 cm. broad'. A gathering made by him at Hakgala differs from the usual form in the smooth capillitium being marked with five to six close spiral bands, and in the spores being closely reticulated with shallow bands and showing about eighteen meshes to the hemisphere. Where the conditions of development have not been entirely favourable it is not unusual to find the capillitium consisting in part of short free elaters.

Hab. On dead wood.—Glasgow (glass-house) ; recorded from France, Germany, Switzerland, Austria, Poland, and Moldavia ; abundant in Japan, the United States and in the tropics ; recorded also from Australia, New Zealand, and the Cape Province.

10. **H. chrysospora** Lister Mycetozoa, 180 (1894) (χρυσός gold, σπέρμα seed). Plasmodium ? Sporangia sessile, crowded or scattered, subglobose, or forming bolster-shaped plasmodiocarps, 0·5 to 1 mm. diam., glossy, bright yellow ; sporangium-wall membranous, with granular thickenings. Capillitium a tangle or network of branching yellow threads, 4 to 5 μ diam., marked with four to five narrow bands arranged in a close, regular spiral, and connected by longitudinal striae ; the threads with many shortly pointed free ends, often attached to various parts of the sporangium-wall. Spores yellow, reticulated with narrow, sharply defined bands, forming a regular net with six to nine meshes to the hemi-

sphere, 14 to 18 μ diam. ; border 1·5 to 2 μ broad.—*Hemiarcyria chrysospora* Lister in Grev., xv. 126 (1887) ; Mass. in Journ. R. Micr. Soc., 1889, 357. *Arcyria chrysospora* Mass. Mon., 164 (1892).

Pl. 169.—*a*. sporangia ; *b*. capillitium and spores with fragment of sporangium-wall ; *c*. capillitium and spore (England).

This species was first found on fallen twigs and moss in a larch plantation near Lyme Regis, November 1886. It has been obtained twice since, also in larch plantations, in Dorset and Devon ; in both these gatherings the capillitium consists in part at least of very long free elaters. *H. chrysospora* appears to be closely allied to the sessile form of *Trichia verrucosa*.

Hab. On dead wood and leaves.—Dorset, Devon, Holstein.

The type of *Hemiarcyria pusilla* Speg. (in Ann. Soc. Cient. Argent., xii. 257 (1881)), from the Argentine Republic, is not met with in the quoted collections ; it is described as being an exceedingly minute species, with nearly sessile, gregarious, rose-coloured and elliptical sporangia, 0·4 to 0·5 mm. high, 0·15 to 0·25 mm. diam. ; capillitium forming a rather dense network of threads, 3 to 4 μ thick, marked with three or four spiral bands and furnished with minute spinules ; spores smooth, 7 to 9 μ diam. The species occurred on bark, and appears to have been found only once.

Genus 45.—**CORNUVIA** Rostafinski Versuch, 15 (1873) (Maxime Cornu, a French botanist, 1843–1901). Sporangia sessile ; capillitium a network of threads with thickenings in the form of rings ; spores reticulated.

1. **C. Serpula** Rost. l.c. (a genus of marine worms with coiled shells). Plasmodium creamy-white. Sporangia sessile, subglobose, about 0·3 mm. diam. or forming small branched or net-like plasmodiocarps, shining golden-yellow ; sporangium-wall membranous, delicate, smooth, pale yellow. Capillitium a flaccid loose network of freely branching yellow threads, 3 to 5 μ diam., marked with well-defined prominent ring-shaped thickenings, arranged at intervals of about 2 μ or irregularly scattered ; junctions of the branches smooth. Spores yellow, reticulated with narrow bands forming a net with from eight to twelve meshes to the hemisphere, 10 to 12 μ diam. ; border 0·5 to 1 μ broad.—Rost. Mon., 289 ; Coon in Journ. R. Micr. Soc., 1907, 142, tt. x, xi. *Arcyria Serpula* Wigand in Pringsh. Jahrb. Bot., iii. 44 (1863). *Ophiotheca Serpula* Mass. Mon., 135 (1892).

Pl. 170.—*d*. sporangia ; *e*. capillitium and spores with fragment of sporangium-wall (Germany).

This minute species frequents tan heaps. The first British gathering was made in the spring of 1906 by Mr. J. M. Coon, who found the shining mature sporangia in abundance on bark in a tanyard at Grampound near St. Austell, Cornwall ; he also observed the young sporangia developing from cream-white plasmodium.

Hab. On tanning bark and dead leaves.—Cornwall, Germany, Denmark, Usambara, East Africa, and North India (see p. 217).

Family II.—Arcyriaceae.

Sporangia simple, stalked or sessile ; capillitium a network of tubular threads branching at wide angles, smooth or thickened with spines, warts, cog-like prominences or half rings (rings in *Arcyria annulifera*), usually abundant (sometimes scanty and of free threads in *Perichaena corticalis*).

KEY TO THE GENERA OF *ARCYRIACEAE*.

A. Capillitium elastic :—

Sporangia stalked ; sporangium-wall evanescent above, persistent as a cup below. (46) Arcyria

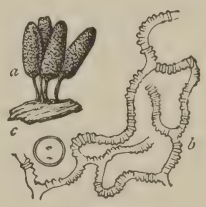


Fig. 53.

Fig. 53.—*Arcyria denudata* Wettstein.
a. Group of sporangia. Twice natural size.
b. Capillitium. Magnified 250 times.
c. Spore. Magnified 560 times.

B. Capillitium not elastic :—

Sporangia sessile, heaped ; sporangium-wall single, persistent, papillose ; capillitium closely warted. (47) Lachnobolus

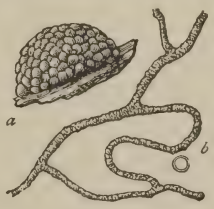


Fig. 54.

Fig. 54.—*Lachnobolus congestus* Lister.
a. Cluster of sporangia. Twice natural size.
b. Capillitium and spore. Magnified 300 times.

Sporangia sessile or stalked ; sporangium-wall usually of two layers, at least at the base, the outer layer thickened with angular granules. (48) Perichaena



Fig. 55.

Fig. 55.—*Perichaena corticalis* Rost.
a. Group of sporangia. Magnified 7 times.
b. Capillitium and spore. Magnified 280 times.

Sporangia sessile, heaped; capillitium smooth; spores clustered. (49) MINAKATELLA

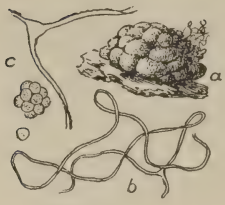


Fig. 56.

Fig. 56.—*Minakatella longifila* G. Lister.

a. Group of sporangia. Magnified 7 times.

b. Capillitium. Magnified 70 times.

c. Cluster of spores and fragment of capillitium. Magnified 170 times.

Genus 46.—**ARCYRIA** Wiggers Fl. Holsat., 109 (1780) (ἄρκυς net). Sporangia stalked (sometimes sessile in *A. occidentalis*); sporangium-wall evanescent above, persistent below as a membranous cup; stalk filled with spore-like cells; capillitium a more or less elastic network with thickenings in the form of half-rings,* cog-like prominences or spines, or marked with a broken reticulation, sometimes with three to five faint spiral lines in addition.

This genus is allied to *Hemitrichia* by those species in which the capillitium is marked with faint spiral bands; but the spirals never constitute the most conspicuous markings of the threads as in *Hemitrichia*.

KEY TO THE GENERA OF *ARCYRIA*.

A. Spores 9 to 11 μ diam.; sporangia orange-red or buff:—

Sporangia ovoid; wall reticulated. 1. *A. ferruginea*

Sporangia clavate; wall papillose. 2. *A. versicolor*

B. Spores 6 to 8 μ diam.:—

A. Cup entire—

a. Capillitium attached to the cup—

Sporangia clavate, grey or yellowish; capillitium closely spinulose or warted. 3. *A. cinerea*

Sporangia clavate, flesh-coloured; capillitium marked with a loose spiral of flat-topped cogs or spines. 4. *A. carnea*

Sporangia globose, yellow; capillitium with spines arranged in an open spiral. 5. *A. pomiformis*

Sporangia globose, whitish, on slender stalks; capillitium closely spinulose or warted, the warts usually arranged more or less in close spiral lines. 6. *A. globosa*

* The thickenings are in the form of minute rings in *A. annulifera*.

Sporangia globose, ochraceous; capillitium very slender, marked with complete rings. 7. *A. annulifera*

Sporangia red, ovoid or subcylindrical; capillitium marked with cogs and half-rings. 8. *A. denudata*

Sporangia rose-coloured, cylindrical or ovoid, small; capillitium threads slender, marked with transverse bands and minute spines. 9. *A. insignis*

Sporangia glaucous; capillitium marked with transverse bands and spines. 10. *A. glauca*

b. Capillitium almost or quite free from the cup—

a. Network of mature capillitium expanding, not drooping—

Capillitium marked with cogs and spines only. 11. *A. incarnata*

Capillitium marked with cogs, spines, and three to four indistinct spiral bands in addition. 12. *A. stipata*

β. Network of mature capillitium becoming much elongated, drooping—

Sporangia buff; wall evanescent above. 13. *A. nutans*

Sporangia red; wall persistent above in a few shield-like fragments. 14. *A. Oerstedtii*

Sporangia yellowish-green. 15. *A. virescens*

B. Cup at length dividing nearly to the base in rounded lobes. 16. *A. occidentalis*

1. **A. ferruginea** Sauter in Flora, xxiv. 316 (1841) (rust-coloured). Plasmodium rose-red or cream-coloured. Total height 1 to 2 mm. Sporangia stalked, crowded, ovoid, 0·7 to 1·3 mm. high, 0·5 to 1 mm. broad, orange-red or red, more rarely ochraceous or yellow, fading to greenish-red on weathering; cup of sporangium even, shining, funnel-shaped, or at length nearly flat, marked with round-meshed reticulation on the inner side. Stalk cylindrical, 0·3 to 0·8 mm. long, 0·05 to 0·15 mm. thick, red, rarely white, arising from a membranous hypothallus, filled with spore-like cells. Capillitium an elastic network of freely branching reddish-yellow or yellow threads, 5 to 6 μ diam., diminishing to 2 to 3 μ diam. towards the base, triangular or oval in section, usually thicker on one side and marked with transverse bars or reticulations arranged in a lax spiral, on the other two sides marked with a broken reticulation or with warts, often spinulose throughout; a few sparingly branched, more slender and smoother

threads penetrate the tube of the stalk, but are not attached to the cup; free ends with rounded or pointed tips are not unfrequent. Spores pale red or ochraceous, faintly and closely warted, 8 to 11 μ diam.—Rost. Mon., 279; Mass. Mon., 144; Macbr. N. Am. Slime-Moulds, ed. 2, 253; Petch in Ann. Perad., iv. 365. *A. coccinea* Duby Bot. Gall., ii. 857 (1830) ? *A. dictyonema* Rost. l.c.; Mass. l.c., 154. *A. intricata* Rost. l.c., App. 37 (1876). *A. cinnamonea* Hazsl. in Oester. Bot. Zeitschr., xxvii. 84 (1877). *A. bonariensis* Speg. in Ann. Soc. Cient. Argent., x. 151 (1880) ? *A. macrospora* Peck in Rep. N. York State Mus., xxxiv. 43 (1881). *A. aurantiaca* Raunk. in Bot. Tidssk., 1888, 61, t. 3, figs. 4, 9 to 11. *A. Raciborskii* Berl. in Sacc. Syll., vii. 430 (1888) ? *A. clavata* Čel. fil. Myx. Böhm., 29 (1893). *A. nodulosa* Macbr. l.c., 252 ? *A. ornata* Widder in Verh. Zool.-Bot. Ges. Wien, lxxiii. 160 (1923). *Sphaerocarpus coccineus* Bull. Champ., 126, t. 368, fig. 1 (1791) ? *Stemonitis coccinea* Gmel. Syst. Nat., 1468 (1791) ? *Trichia fulva* Wither. Brit. Pl., ed. 2, iv. 479 (1792) ? *T. polymorpha* Sow. Engl. Fung., t. 180 (1799) *nomen*. *T. expansa* Martius in K. Baier. Ak. Wiss., 1853, 224 ? *Arcyrella inermis* Racib. in Rozpr. Mat. Przyr. Ak. Krak., xii. 82 (1884). *A. decipiens* Racib. l.c., 84 ? *A. cornuvioides* Racib. in Hedw., xxviii. 123 (1889) ? *Hemiarcyria expansa* Sacc. Syll. Fung., xviii. 212 (1906).

Var. **Heterotrichia** Torrend Fl. Myx., 98 (1909) (ἕτερος different, and *Trichia*). Capillitium a dense network with many pointed free ends, threads closely reticulated and spinulose all over, 5 to 8 μ diam.—*Heterotrichia Gabriellae* Mass. Mon., 140 (1892); Macbr. l.c., 198. *Arcyria ferruginea* var. *Gabriellae* Grove in Birm. Nat. Hist. Phil. Soc., xii. 20 (1910).

Pl. 173.—*a*. sporangia; *b*, *c*. threads from upper part of capillitium; *d*. thread from basal part of capillitium; *e*. capillitium of form named *A. dictyonema* Rost. (Germany); *f*. capillitium of var. *Heterotrichia* (South Carolina); *g*. portion of sporangium-wall; *h*. spores.

The sporangia of this species vary much in colour; large developments are often met with in which the more central sporangia are brick- or orange-red, while the outer are yellow or buff. The markings on the capillitium also vary considerably; the threads of a single sporangium may be in some parts conspicuously thickened on one side while in other parts they are not thickened, and are spinulose all over. In the type of *A. dictyonema* Rost., from Freiburg, the capillitium is spinose, principally on one side of the thread, and marked with broken reticulation and spinules on the other part; there are numerous free branches with clavate or pointed ends; except that the spines are more developed than usual, the markings do not differ from those frequently seen in typical *A. ferruginea*, of which it is clearly a form. The type of *Heterotrichia Gabriellae* Mass., from South Carolina (K. 838), has numerous pointed free ends in the upper part of the net of the capillitium; the threads are flattened, very closely reticulate and spinulose, and in many places thickened on one side; the spores measure 10 to 11 μ. A similar form is often met with in the British Isles

when the conditions of development have not been entirely favourable ; free ends are usually abundant in sporangia that have matured in cold weather. As this variety is not unfrequent, for convenience of reference we follow Dr. Torrend in distinguishing it as var. *Heterotrichia*. An abnormal form of *A. ferruginea* was found by Prof. Schinz near Goldau, Switzerland, in September 1902 (B.M. slide) ; the sporangia are very shortly stalked or sessile, the slender capillitium threads measure 2·5 to 3 μ diam., and are beaded at short intervals with globular or ovoid swellings, 10 μ thick, which are marked with a close reticulation of raised bands ; the threads between the swellings are nearly smooth ; the spores average 10 to 12 μ, but there are also many monstrous and irregular spores. It is not unusual to find globular expansions in the threads of more normal developments, but this gathering has them in great abundance. From the description and illustration of *A. nodulosa* Macbr., with capillitium showing swollen nodes and spores 10 to 12 μ diam., it is possible that it may be a similar irregular form of the present species.

Hab. On dead wood ; abundant in the British Isles in autumn and winter ; widely distributed in temperate regions, and recorded also from Ceylon.

2. **A. versicolor** Phillips in Grev., v. 115 (1877) (particoloured). Plasmodium ? Total height 2·5 to 3 mm. Sporangia shortly stalked or sessile, gregarious or clustered, pyriform or clavate, 1 to 2 mm. diam., more or less shining, yellow or olivaceous-yellow ; sporangium-wall membranous, persistent except at the apex, yellow, papillose on the inner side. Stalk 0·2 mm. long, yellow-brown, filled with spore-like cells, arising from a well-developed hypothallus. Capillitium an elastic network of freely branching yellow threads, 4 to 6 μ diam., triangular or oval in section, either uniformly spinulose and marked with broken reticulation, or with one side thickened and marked with transverse bars ; the threads arise from the tube of the stalk, and are not attached to the sporangium-wall ; free ends shortly pointed. Spores yellow, smooth, 8 to 10 μ diam.—Mass. Mon., 149. *Arcyria vitellina* Phill., l.c. ; Macbr. N. Am. Slime-Moulds, ed. 2, 250.

Pl. 175.—*a.* sporangia ; *b.* portion of sporangium-wall ; *c.* capillitium and spore (California).

This species is allied to *A. ferruginea*, from the yellow form of which it differs in shape, in the papillose thickenings of the sporangium-wall, and in the smoother spores. *A. vitellina* Phill. from California is the same species.

Hab. On dead wood : recorded from Canton Vallais, Switzerland, Styria, Moldavia, and the western United States.

3. **A. cinerea** Pers. Syn. Fung., 184 (1801) (ashy). Plasmodium greyish-white. Total height 0·8 to 4 mm. Sporangia stalked, gregarious or solitary, single or united in clusters of two to six, ovoid or cylindrical, more rarely globose, 0·5 to 0·8 mm. diam., pale grey, greenish- or bluish-grey, or greyish flesh-colour, fading to dull yellow ; cup of the sporangium-wall membranous, nearly smooth, minutely papillose or reticulated, plaited at the base, pale grey or yellowish. Stalk

cylindrical, furrowed, 0·2 to 2 mm. long, 0·05 to 0·15 mm. thick, white, grey or brown, filled with spore-like cells. Capillitium a close network of grey or yellowish-grey threads; the upper and middle threads 2 to 4 μ diam., closely warted, transversely banded, or spinulose, the spines often stouter and larger on one side; the threads composing the basal part of the network 4 to 6 μ diam., either smooth, faintly warted, or reticulated, with numerous attachments to the cup. Spores almost colourless, marked with a few scattered warts, 6 to 8 μ diam.—Rost. Mon., 272; Mass. Mon., 151; Macbr. N. Am. Slime-Moulds, ed. 2, 254. *Trichia cinerea* Bull. Champ., 120 (1791). *Stemonitis cinerea* Gmel. Syst. Nat., 1467 (1791). *S. glauca* Trentep. in Roth Catal. Bot., i. 221 (1797). *Arcyria albida* Pers. in Roemer N. Mag. Bot., i. 90 (1794); Lister Mycetozoa, 186. *A. straminea* Wallr. Fl. Crypt. Germ., ii. 383 (1833)? *A. trichioides* Corda Icon., ii. 23, t. 12, fig. 86 (1838). *A. Friesii* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 4, xvii. 140 (1876). *A. Cookei* Mass. l.c., 154 (1892). *A. tenuis* Schroet. in Hedw., xxxv. 207 (1896). *Lachnobolus Arcyrella* Rost. l.c., 431 (1875)? *Comatricha alba* Schulzer in Just Bot. Jahresb., 155 (1877).

Var. **digitata** G. Lister (having fingers). Sporangia cylindrical, on long dark stalks adhering in clusters of three to seven or more.—*Stemonitis digitata* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 260 (1832). *S. grisea* Opiz in Lotos, 1855, 215. *Arcyria Leprieuri* Mont. in Ann. Sc. Nat. Bot., ser. iv, iii. 141 (1855). *A. bicolor* Berk. & Curt. in Journ. Linn. Soc., x. 349 (1869). *A. pallida* Berk. & Curt. in Grev., ii. 67 (1873). *A. digitata* Rost. l.c., 274; Macbr. l.c., 255. *A. stricta* Rost. l.c., App. 36 (1876).

Pl. 176.—*a*, *b*. sporangia; *c*. globose sporangium on bramble stalk; *d*, *d*^{1}. outer threads of capillitium; *e*. spore (England).

In this species the shape of the sporangium is very variable. An extensive growth of the common grey form arising from one development of plasmodium will often exhibit much diversity; subglobose sporangia with short stalks and subcylindrical sporangia with long stalks are found in company with the more usual ovoid form; they are either single, or are combined in clusters. Developments are met with on dead bramble stems and holly leaves in which the nearly white sporangia are shortly stalked and perfectly globose, 0·5 to 0·7 mm. diam. (= *A. digitata* var. *subglobosa* Meyl. in Ann. Cons. Bot. Genève, 1913, 321), associated with other groups of sporangia varying from subglobose to ovoid. Sporangia formed on dead leaves are usually scattered or solitary. The markings of the capillitium are also variable; usually they consist of minute spines closely and uniformly distributed, but sometimes a band of larger spines is present. In cold weather developments the capillitium-threads may be broad (5 μ diam.), flat and papillose all over. The type specimen of *A. Friesii* Berk. & Br. from Glamis, N.B. (K. 896), is a bluish-grey ovoid form of the present species, with typical capillitium and spores. The type of *A. Cookei* Mass., from Brazil (K. 865), is a tall grey form of *A. cinerea*: the sporangia measure

2 mm. in length, 0·5 mm. in breadth ; the stalks are 2 mm. long, 0·1 mm. thick.

Hab. On dead wood, twigs, or on dead leaves : common and widely distributed ; var. *digitata* is especially abundant in the tropics.

4. **A. carnea** G. Lister in Journ. Bot., lix. 92, pl. 558, figs. 2, 2 *a*, *b* (1921) (flesh-coloured). Plasmodium ? Sporangia stalked, loosely clustered, ovoid or shortly cylindrical, flesh-coloured, 1·5 mm. high ; cup marked with papillae or with a broken reticulation, giving attachment to the capillitium. Stalks short, 0·2 to 0·4 mm. high. Capillitium a compact network of pale flesh-coloured threads about 3·5 μ diam., marked with close-set prominences arranged in a loose spiral and appearing square-ended, notched or hammer-shaped in profile ; the remainder of the thread either spinulose or marked with a broken reticulation or occasionally with three or four faint irregular spiral bands ; basal threads smoother. Spores 6 to 8 μ diam., nearly smooth.—*A. cinerea* var. *carnea* Lister Mycetozoa, ed. 2, 236 (1911).

It is quite possible that *A. carnea* Schum. (Enum. Pl. Saell., ii. 213 (1803)) may have been the present species, but the description is too brief for any certainty. It is distinguished from *A. cinerea* by the compact flesh-coloured sporangia, which sometimes form large colonies, and by the square-topped ' cogs ' of the capillitium. Prof. Brandza writes that he has found it at least twenty times in Roumania.

Hab. On dead wood ; recorded from Sussex, Surrey, Essex, Hertfordshire, France, North and Central Germany, Bohemia, Roumania, and Japan.

5. **A. pomiformis** Rost. Mon., 271 (1875) (apple-shaped). Plasmodium white. Sporangia scattered, stalked, subglobose or ovoid, 0·3 to 0·7 mm. diam., ochraceous-yellow ; cup of sporangium-wall plaited at the base, nearly smooth, faintly reticulated or papillose. Stalk slender, buff, 0·2 to 0·4 mm. high, filled with spore-like cells. Capillitium a loose elastic network of yellowish threads, about 3 μ diam., marked with transverse bands and spines arranged in an open spiral, nearly smooth elsewhere. Spores nearly colourless, 7 to 8 μ diam., marked with a few scattered warts.—Macbr. N. Am. Slime-Moulds, ed. 2, 255. *Mucor pomiformis* Leers Fl. Herborn, 218 (1775) ? *Stemonitis pomiformis* Roth Fl. Germ., 548 (1788). *S. ochroleuca* Trentep. in Roth Catal. Bot., i. 221 (1797). *S. lutea* Trentep. l.c. *Arcyria umbrina* Schum. Enum. Pl. Saell., ii. 213 (1803) ? *A. silacea* Ditm. in Sturm Deutsch. Fl., Pilze, i. 15, t. 8 (1813). *A. lutea* Schwein. Syn. Fung. Carol., 37 (1822). *A. ochroleuca* Fr. Syst. Myc., iii. 181 (1829). *A. Winteri* Wettst. in Oesterr. Bot. Zeitschr., xxxv. 199 (1885). *A. albida* var. *pomiformis* Lister Mycetozoa, 186 (1894).

Pl. 176.—*f*, *f*^{1}. outer threads of capillitium-net (England).

Distinguished from *A. cinerea* by the scattered buff sporangia with looser

capillitium. The basal threads are sometimes marked with three or four faint spiral bands.

Hab. On dead wood, especially on fallen branches of oak, sometimes on bark of living trees: frequent in England; recorded from Ulster, France, Sweden, Germany, Switzerland, Poland, Austria, Moldavia, Portugal, Cape Province, Japan; widely distributed in the United States.

6. **A. globosa** Schwein. Syn. Fung. Carol., 38 (1822). Plasmodium ? Sporangia scattered or gregarious, stalked, globose, 0·3 to 0·6 mm. diam., white or pale yellow, or brownish with age; cup of sporangium shallow or rather deep, membranous, smooth or papillose, often minutely and transversely wrinkled. Stalk pale yellow or brown, slender, 0·2 to 0·5 mm. high, filled with spore-like cells. Capillitium a close and only slightly elastic network of colourless threads, 2 to 4 μ diam., marked with warts or spines usually arranged along three or four spiral lines which run from the left above to the right below when the thread is viewed horizontally (in the reverse direction to the sinistral spirals of *Trichia* elaters); sometimes the threads are irregularly reticulated between the spines. Spores colourless, 6 to 8 μ diam., marked with a few scattered warts.—Petch in Ann. Perad., iv. 365. *Craterium globosum* Fr. Syst. Myc., iii. 154 (1829). *Lachnobolus globosus* Rost. Mon., 283 (1875); Mass. Mon., 137; Macbr. N. Am. Slime-Moulds, ed. 2, 245. *Arcyria albida* var. *globosa* Lister Mycetozoa, 186 (1894).

Pl. 176.—*g.* sporangium on chestnut-bur (Alleghany Mountains); *h.* capillitium; *i.* sporangia on male flower of chestnut.

This species was transferred by Rostafinski to the genus *Lachnobolus*, but its chief features—the stalked sporangia, the persistent cup of the sporangium-wall and the somewhat elastic capillitium, are characteristic rather of *Arcyria*. *A. globosa* is distinguished from *A. cinerea*, its nearest ally, by the globose shape of the sporangia, the less elastic capillitium, and usually by the spiral arrangement of the markings on the threads. An indication of spiral markings sometimes occurs in some of the threads of *A. cinerea*, but less definitely than in the present species and in the reverse direction. In North America *A. globosa* appears frequently on the burs and male catkins of the 'Chinquapin' (*Castanea dentata* Borkh.), and also on dead leaves. Mr. Petch has extended our knowledge of its range by discovering a group of about a dozen typical sporangia on a dead leaf at Peradeniya, Ceylon.

Hab. On dead leaves, and the burs and male flowers of *Castanea dentata* Borkh.—Ceylon, and the Eastern United States.

7. **A. annulifera** Torrend Fl. Myx., 102 (1909) (*annulus* ring, *fero* I bear). Plasmodium ? Sporangia scattered, stalked, subglobose or ovoid, 0·5 to 0·6 mm. diam., buffish-yellow; cup of sporangium-wall membranous, papillose, buff, rather deep, with an irregular margin, plicate below. Stalk buff, 0·2 to 0·4 mm. high, filled with spore-like cells. Capillitium a somewhat flaccid network of slender yellowish threads, 1 to 1·5 μ diam., marked at intervals of 1 to 2 μ with

prominent ring-shaped thickenings 1 μ diam., basal threads 2 μ diam., marked with a series of moniliform swellings 2 to 3 μ long. Spores pale yellow, marked with a few scattered warts, 6 to 7 μ diam.—Torrend in Bull. Soc. Port. Sci. Nat., ii. 73 (1908) (*nomen*).

Pl. 185.—*c.* sporangia; *d.* spores and capillitium with fragment of sporangium-wall (Portugal).

This species closely resembles *A. pomiformis* in outward appearance; it is distinguished by the more slender capillitium marked with complete annular thickenings. The only example hitherto obtained is the type gathered by Dr. C. Torrend, near Cintra, in the spring of 1908.

Hab. On pine needles.—Portugal.

8. **A. denudata** Wettstein in Verh. Zool.-Bot. Ges. Wien, 585 (1885–6) (naked). Plasmodium white. Total height 2 to 3 mm. Sporangia stalked, crowded or gregarious, ovoid or sub-cylindrical, 0·9 to 1·8 mm. high, 0·8 to 1 mm. broad, crimson, weathering to reddish-brown or brown, rarely pale red; cup of sporangium-wall membranous, firm, shining, plaited, smooth or marked with scattered papillae and faint broken reticulations on the inner side. Stalk cylindrical, 0·5 to 1 mm. high, 0·1 mm. thick, furrowed, red-brown, filled with spore-like cells. Capillitium a rather close elastic network of flattened or terete pale red threads, 2 to 5 μ diam., with thickenings in the form of prominent cogs or spines and half-rings arranged in a loose spiral; with many attachments to the cup, and usually without free ends. Spores pale red, nearly smooth, marked with a few scattered warts, 6 to 8 μ diam.—Macbr. N. Am. Slime-Moulds, ed. 2, 253. *Clathrus denudatus* L. Syst. Nat., 1179 (1753). *Mucor clathroides* Scop. Fl. Carn., ed. 2, ii. 493 (1772). *M. pyriformis* Leers Fl. Herborn, 288 (1775). *Stemonitis coccinea* Roth Fl. Germ., 548 (1788). *S. crocea* Gmel. Syst. Nat., 1467 (1791). *S. denudata* Relh. Fl. Cant., ed. 3, 574 (1820). *Lycoperdon rufum* Dicks. Pl. Crypt. Brit., i. 25 (1785) ? *Embolus crocatus* Batsch Elench. Fung., Cont. i. 266, fig. 177 (1786). *Trichia denudata* Vill. Pl. Dauph., 1060 (1789). *T. graniformis* Hoffm. Veg. Crypt., i. 3 (1790). *T. cinnabarina* Bull. Champ., 121, t. 502, fig. 1, *b*, *c* (1791). *T. rufa* Wither. Br. Pl., ed. 2, iii. 478 (1792). *T. purpurea* Schum. Enum. Pl. Saell., ii. 211 (1803) ? *Arcyria punicea* Pers. in Roemer N. Mag. Bot., i. 90 (1794); Rost. Mon., 268; Lister Mycetozoa, 188. *A. dentata* Schum. l.c., 213 ? *A. rufa* Schum. l.c., 214 ? *A. melanocephala* Schum. l.c. ? *A. conjugata* Schum. l.c., 215. *A. cylindrica* Schum. l.c. ? *A. cincta* Schum. l.c. ? *A. fusca* Fr. Symb. Gast., 17 (1818) ? *A. vernicosa* Rost. l.c., App. 36 (1876).

Pl. 174.—*a.* sporangia; *b.* capillitium-threads, showing attachment to cup and spore; *c.* spinulose capillitium from another sporangium.

This abundant and widely distributed species shows considerable variety in the colour and markings of the capillitium and in the thickness of the

threads. In cold weather developments the threads are stout, dark red, and rough with close-set cogs and spines; in more normal growths they are pale pink and the markings consist only of a loose spiral of smooth cogs or half-rings. A long-stalked rose-coloured specimen, gathered by Rev. W. Cran in Antigua (B.M. 1686), shows unusually slender threads 2 μ diam., marked only with a spiral of prominent transverse bands 1·5 μ in depth; the capillitium is firmly attached to the shallow cup. Forms of *A. denudata* occur in which some threads of the capillitium show, beside the usual markings, an irregular reticulation, or an indication of three or four faint spiral bands, suggesting an approach to *A. stipata*.

Hab. On dead wood: common throughout the year in the British Isles, and abundant in temperate and tropical regions.

9. **A. insignis** Kalchbr. & Cooke in Grev., x. 143 (1882) (remarkable). Plasmodium watery-white. Total height 0·5 to 1·5 mm. Sporangia stalked, gregarious or clustered in scattered groups, ovoid or cylindrical, 0·3 to 0·4 mm. diam., pale rose-coloured; cup of sporangium-wall delicately membranous, plaited, nearly smooth or reticulated and spinulose. Stalk thickened upwards, furrowed, 0·2 to 0·4 mm. long, red, filled with spore-like cells. Capillitium a close elastic network of pale pink delicate threads, from 2 to 3 μ diam., usually with a few bulbous free ends, flattened, marked with transverse bands and short spines arranged in a lax spiral, closely and minutely spinulose or nearly smooth elsewhere. Spores when magnified almost colourless, nearly smooth, 6 to 8 μ diam.—Mass. Mon., 148; Torrend Fl. Myx., 99; Petch in Ann. Perad., iv. 366; Macbr. N. Am. Slime-Moulds, ed. 2, 256.

Var. **major** G. Lister (larger). Sporangia cylindrical, bright rose-red, 1 to 2 mm. high, expanding into a column 2·5 to 3 mm. long; capillitium with transverse ridges well developed.

Pl. 181.—*a*. sporangia; *b*. spores, and capillitium showing attachment of threads to the cup.

This widely distributed species somewhat resembles a small form of *A. incarnata*, but is distinguished by the pure rosy colour of the sporangia, and the closer network of the capillitium, the threads of which are extremely flaccid and almost colourless when mounted in water, and are attached to the wall of the cup. The var. *major* is a larger, more brightly coloured form, with the capillitium-threads less compressed, and with more prominent markings; in the mountain woods of Moldavia it occurs on oak wood, where Prof. Brandza writes, the typical form is common. A minute form with scattered sporangia 0·1 to 0·3 mm. high on long slender stalks was found by Mr. A. R. Sanderson on dead but unshed leaves at Petaling, Fed. Malay States.

Hab. On dead wood, &c.: not uncommon in the tropics; recorded also from Germany, Moldavia, Portugal, S. Africa, Malaya, South Australia, Japan, and Massachusetts: var. *major* recorded from Bedfordshire, Moldavia, Ceylon, and Brazil.

10. **A. glauca** Lister ex Minakata in Bot. Mag. Tokyo, xxii. 322 (1908) (pale or bluish-green). Plasmodium ? Spor-

angia stalked, grouped in clusters of four to twenty, ovoid or cylindrical, 0·4 to 2·5 mm. high and 0·4 to 0·8 mm. broad when expanded, pale bluish-green ; cup of sporangium-wall funnel-shaped, membranous, somewhat plaited, marked with a faint reticulation. Stalk pale green or greyish-brown, curved and weak, 0·2 to 0·3 mm. high, filled with spore-like cells. Capillitium an elastic network of pale threads, 2·5 to 3 μ diam., with many attachments to the cup and few rounded free ends, marked with a loose spiral of prominent cog-like transverse bands ; elsewhere either nearly smooth or with thickenings in the form of scattered spinules and an irregular reticulation, or with three or four faint spiral lines. Spores pale glaucous, nearly smooth, 7 μ diam.

Pl. 182.—*a*. sporangia ; *b*. capillitium and spores, with fragment of sporangium-wall showing attachment of the capillitium-threads (Japan).

This rare and beautiful species has been found twice only, in the summer of two successive years, by Mr. Kumagusu Minakata. It appeared on a rotting limb of a Chinese Camphor-tree (*Machilus Thunbergii* Sieb. & Zucc.) growing by a shrine of the Shinto monkey-god at Itoda, in the province of Kii, Japan. The shrine has since been removed and the grove surrounding it cut down. When freshly gathered, *A. glauca* is of a pale glaucous or bluish-green colour ; after a time it fades to greenish-drab. The markings of the capillitium somewhat resemble those of *A. insignis*.

Hab. On dead wood.—Province of Kii, Japan.

11. **A. incarnata** Pers. Obs. Myc., i. 58, t. v, figs. 4, 5 (1796) (flesh-colour). Plasmodium white. Sporangia stalked or nearly sessile, crowded, subcylindrical or ellipsoid, 1 to 1·5 mm. high, 0·6 mm. broad, pink ; cup of sporangium-wall membranous, even or plicate, spinulose. Stalk weak, 0·1 to 0·3 mm. long, flesh-coloured, filled with spore-like cells. Capillitium a very loose elastic network of pale pink threads, 3 to 5 μ diam., sparingly and somewhat irregularly branched, with here and there broad perforated or ring-like expansions, often swollen at the axils of the branches ; thickenings in the form of sharp cogs, half rings, or spines arranged in a loose spiral, and of minute scattered spinules ; free ends more or less numerous, clavate or pointed, spinose. Spores pale pink, marked with a few scattered warts, 6 to 8 μ diam.—Rost. Mon., 275 ; Mass. Mon., 145 ; Macbr. N. Am. Slime-Moulds, ed. 2, 251. *Stemonitis incarnata* Pers. in Gmel. Syst. Nat., 1467 (1791). *S. Trichia* Roth Fl. Germ., i. 549 (1788) ? *S. carnea* Trentep. in Roth Catal. Bot., i. 222 (1797) ? *S. globosa* Trentep. l.c. ? *Clathrus adnatus* Batsch Elench. Fung., 141 (1783) ? *Trichia flexuosa* Schum. Enum. Pl. Saell., ii. 209 (1803). *Arcyria lilacina* Schum. l.c., 212. *A. minor* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 259 (1832) ? *A. adnata* Rost. l.c., App. 36 (1876). *A. irregularis* Racib. in Rozpr. Mat. Przyr. Ak. Krak., xii. 83 (1884).

Var. **fulgens** Lister Mycetozoa, ed. 2, 242 (1911) (bright). Sporangia crimson; stalks firm, dark reddish-brown.—*A. affinis* Rost. Mon., 276 (1875) ? *A. similis* Racib. in Rozpr. Mat. Przyr. Ak. Krak., xii. 81 (1884) ?

Pl. 177.—*a.* sporangia; *b.* capillitium and spore, with fragment of sporangium-wall (England).

This species is closely allied to *A. denudata*, from which it is chiefly distinguished by the capillitium having free ends and being free from the cup, and by the more diffusely expanding net; intermediate forms are of not unfrequent occurrence. *A. incarnata* var. *helvetica* Meylan (Bull. Soc. Vaud. Sc. Nat., xlvi. 55 (1910)) appears to be such an intermediate form; M. Meylan describes the capillitium as being free from the cup, but in the specimens he courteously sent me many attachments are present. *A. minor* Schwein. seems to be an intermediate form also; Dr. Sturgis has examined the type and finds it similar to *A. denudata*, except that the capillitium is free from the cup; there are no 'free ends' and the threads are marked with a very open spiral of blunt ridges; the species described by Prof. Brandza as *Arcyria* sp. non det (Ann. Sc. Univ. Jassy, viii. 269, fig. 2 (1914)), seems to agree well with *A. incarnata*, except that the plasmodium is said to have been reddish-brown.

Hab. On dead wood and sticks: common in the British Isles throughout the year, and widely distributed in all temperate regions; recorded also from Java: var. *fulgens* is not uncommon in England and Ireland, and has been recorded from France, Switzerland, Moldavia, from many parts of Australia and New Zealand, from Canada, and the State of New York.

12. **A. stipata** Lister Mycetozoa, 189 (1894) (crowded). Plasmodium ? Total height 1·5 to 2 mm. Sporangia stalked or nearly sessile, crowded, cylindrical, erect or curved, 1 to 1·5 mm. high, 0·6 mm. broad, either copper-coloured, or deep brown with a carmine tinge or scarlet; sporangium-wall irregularly evanescent above, persistent as a plaited or smooth cup, papillose or faintly reticulated near the rim. Stalk cylindrical, 0·1 to 1 mm. long, red-brown or brownish-black, filled with spore-like cells, rising from a membranous hypothallus. Capillitium a more or less elastic network of freely branching threads, 2·5 to 3·5 μ diam., marked with an open spiral of broad-based spines or transverse ridges, and with three to four faint spiral bands, sometimes with minute spines in addition; with many free clavate ends and few attachments to the cup. Spores pale red, smooth with few scattered warts, 6 to 8 μ diam.—Petch in Ann. Perad., iv. 367. *Leangium stipatum* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 258 (1832). *Hemiarcyria stipata* Rost. Mon., App. 41 (1876). *Hemitrichia stipata* Macbr. N. Am. Slime-Moulds, ed. 2, 262 (1922); Torrend Fl. Myx., 107.

Pl. 178.—*a.* sporangia, with expanded capillitium; *b.* threads of upper part of capillitium; *c.* threads from base of capillitium; *d.* spore (Ceylon); *e.* sporangia (Iowa); *f.* upper part of capillitium; *g.* threads from base of capillitium.

This species is widely distributed, and is not uncommon in the United States. The faint spirals on the threads are often evident in parts of the capillitium only, and are most conspicuous on the basal threads; the

latter are almost free from spines and transverse bands. The sporangia vary in colour and in the length of their stalks. Some developments are nearly sessile, and have closely compacted curved copper-coloured sporangia with deep ill-defined cups, and a loose network of flaccid capillitium, the threads of which are sometimes nearly smooth. In other gatherings the sporangia are deep red, scarlet or coppery, the stalks are long, the cups well-defined, and the capillitium forms an elastic network of freely branching threads marked with close-set blunt-ended transverse bands and numerous spinules.

Hab. On dead wood : recorded in England from Kent, Surrey, and Yorkshire ; also from Finland, North Germany, Ceylon, Nepaul and from near Simla (North-West India), Japan, Fiji, the United States, and Canada.

13. **A. nutans** Grev. Fl. Edin., 455 (1824) (nodding). Plasmodium watery-white. Sporangia stalked, clustered, cylindrical, when unexpanded 1·5 to 2 mm. high, 0·3 to 0·5 mm. broad ; ochraceous-yellow or pale buff ; cup of sporangium-wall membranous, flaccid, reticulated and often spinulose on the inner side, interruptedly plicate. Stalk buff, short or elongated, weak, filled with spore-like cells. Capillitium an elastic network of pale yellow terete or flattened threads 3 to 4 μ diam., expanding into a drooping column 8 to 12 mm. in length, free from the cup, or with few attachments ; thickenings on the threads in the form of sharp spines and half-rings arranged in a loose spiral, and of scattered spinules and short lines of broken reticulation ; free ends more or less numerous, clavate. Spores pale yellow, nearly smooth, marked with a few scattered warts, 6 to 8 μ diam.—Rost. Mon., 277 ; Mass. Mon., 150 ; Macbr. N. Am. Slime-Moulds, ed. 2, 249. *Trichia nutans* Bull. Champ., 122, t. 502, fig. 3 (1791). *T. elongata* Schum. Enum. Pl. Saell., ii. 209 (1803). *Stemonitis nutans* Gmel. Syst. Nat., 1467 (1791). *S. amoena* Trentep. in Roth Catal. Bot., i. 222 (1797). *Arcyria flava* Pers. in Roemer N. Mag. Bot., i. 90 (1794) ; Lister Mycetozoa, 190. *A. alutacea* Schum. l.c., 212.

Pl. 179.—*a*. sporangia ; *b*. capillitium and spores with fragment of cup of sporangium-wall (England).

Hab. On dead wood : frequent in temperate and tropical regions.

14. **A. Oerstedtii** Rost. Mon., 278 (1875) (Prof. A. Oerstedt, a Danish botanist, 1816 to 1874). Plasmodium watery-white. Sporangia forming large colonies, stalked, clustered, cylindrical, curved, rising from a colourless membranous hypothallus, when unexpanded 0·6 to 1·5 mm. high, 0·3 to 0·5 mm. broad, dull crimson ; sporangium-wall evanescent above, or persistent in the form of a few well-defined rounded plates, which are papillose on the inner side, smooth on the margin ; cup membranous, faintly reticulated and marked with scattered papillae ; rim smooth. Stalks pale red, varying in length, usually short, weak, filled with spore-like cells. Capil-

litium an elastic network of pale red threads 3 to 5 μ diam., expanding into a long drooping cylindrical column ; thickenings in the form of half rings and sharp spines 1 to 3 μ long, arranged in a loose spiral, elsewhere marked with scattered spinules, and often with four or five faint irregular spiral bands ; some threads attached to the persistent plates of the sporangium-wall, others to the cup ; free ends with spinulose tips are sometimes present. Spores pale red, nearly smooth, marked with few scattered warts, 7 to 8 μ diam.—Mass. Mon., 147 ; Macbr. N. Am. Slime-Moulds, ed. 2, 249 ; Petch in Ann. Perad., iv. 367. *A. vermicularis* Schum. Enum. Pl. Saell., ii. 212 (1803) ? *A. punicea* var. *vermicularis* Fr. Syst. Myc., iii. 178 (1829) ? *A. incarnata β flexuosa* Fr. l.c., 179. *A. flexuosa* Rab. Deutsch. Krypt. Fl., i. 258 (1844) ? *A. fuliginea* Cooke & Mass. in Mass. l.c., 169 (1892). *A. magna* Rex in Proc. Acad. Nat. Sci. Phil., 1893, 364 ; Macbr. l.c., 248. *Hemiarcyria fuliginea* Cooke & Mass. in Grev., xvi. 74 (1888).

Pl. 180.—*a*. sporangia ; *b*. shield-like persistent portion of sporangium-wall with capillitium threads attached ; *c*. capillitium with fragment of cup, and spore.

The present species differs from *A. nutans* in colour, and in the spines on the capillitium being more slender and closely set and more evenly distributed, also in the presence of portions of the sporangium-wall adhering to the capillitium. Prof. Brandza finds this species in prodigious abundance in the mountain forests of Moldavia, especially on fir and old beech logs which have lain rotting for the last seventy years ; here it spreads, with interruptions, over several metres in length, making the herbage around red with its spores. The type of *Hemiarcyria fuliginea* Cooke & Mass. from New South Wales (K. 154) resembles typical gatherings of the present species, except in the colour, which has faded to fuliginous-brown. *Arcyria magna* Rex, and *A. magna* var. *rosea* Rex (B.M. 1518), are respectively tawny-grey and rosy-red forms of *A. Oerstedtii* ; they were found twice in Fairmount Park, Philadelphia, each time closely associated on the same log of wood. The capillitium expands into long drooping columns, to which in var. *rosea* persistent papillose plates of the sporangium-wall are attached.

Hab. On dead wood : not uncommon in England, and recorded from Scotland : widely distributed in Europe, recorded from South Nigeria, Cape Province, Uganda, Ceylon, Malaya, Java, Australia, Japan ; widely distributed but uncommon in the United States.

15. **A. virescens** G. Lister in Journ. Bot., lix. 252 (1921) (becoming green). Plasmodium white. Sporangia crowded or clustered, often forming large colonies, stalked, cylindrical, yellowish-green ; cup of sporangium-wall narrowly funnel-shaped, reticulated and spinose on the inner side. Stalks slender, straight or flexuose, dark olive-green, free or adhering in clusters of three to ten, 0·5 to 1·5 mm. long. Capillitium a loose elastic network of greenish or khaki-coloured threads, free from the cup, and expanding into a column about 6 mm. long ; threads 4 to 6 μ wide, marked with scattered groups of close-set prominent transverse ridges, 3 to 5 μ high, arranged

more or less in an open spiral ; the remaining surface irregularly reticulated and roughened with delicate, often broad-based spines. Spores yellowish-green in mass, 7 to 8 μ diam., smooth except for a few scattered warts.

Pl. 222.—*a*. group of sporangia, from all but three the capillitium has gone ; *b*. portions of the cup and capillitium, and a spore.

This species differs from *A. glauca*, the only other member of the genus with green spores, in the long dark stalks, the narrow cups and stouter capillitium marked with groups of prominent bands, as well as in the yellower colour of both capillitium and spores. The elasticity of the capillitium and the ease with which the loose columns separate from the sporangial cups cause rapid dispersion of the spores ; this probably accounts for the species having been long overlooked and regarded as a faded form of *A. nutans*. Mr. A. R. Sanderson finds it not uncommon and forming beautiful colonies in the neighbourhood of Johore, Federated Malay States ; he also saw the opaque white plasmodium emerging from dead wood.

Hab. On dead wood.—Ceylon, Malaya, Queensland.

16. **A. occidentalis** Lister Mycetozoa, ed. 2, 245 (1911) (western). Plasmodium white, then rosy. Sporangia scattered or crowded, stalked or sessile, often angled by mutual pressure, ellipsoid, 0·7 to 0·9 mm. high, 0·4 to 0·5 mm. broad, rosy copper-coloured fading to yellowish-buff ; sporangium-wall more or less evanescent above, persistent at the sides and at length dividing into four to six deep rounded membranous and papillose lobes. Stalk yellowish-brown, straight or curved, 0·1 to 0·3 mm. high, filled with spore-like cells. Capillitium a loose network of pinkish-yellow threads, 2·5 to 4 μ diam., with few attachments to the sporangium-wall, marked with spines, warts, and low transverse bands, arranged in an open spiral, otherwise nearly smooth or minutely papillose ; free ends more or less numerous, clavate, papillose. Spores in mass flesh-coloured fading to buff, smooth except for a few scattered warts, 6 to 7 μ diam.—*Lachnobolus incarnatus* Macbr. in Bull. Nat. Hist. Iowa, ii. 126 (1892). *L. occidentalis* Macbr. N. Am. Slime-Moulds, ed. 2, 246 (1922).

Pl. 192.—*a*. sporangia ; *b*. capillitium and spores with fragments of sporangium-wall (Iowa).

This species somewhat resembles the smaller forms of *A. stipata*, but is distinguished by the cup of the sporangium dividing into rounded lobes, and by the absence of spiral bands on the threads of the capillitium. The flaccid character of the capillitium is not more marked than in many gatherings of *A. stipata*, and can hardly be regarded as of sufficient importance to separate *A. occidentalis* from the genus *Arcyria*.

Hab. On dead wood : widely distributed in the United States, being recorded from Maine, New Hampshire, Missouri, Nebraska, and Iowa ; also from Ottawa and Winnipeg in Canada.

Genus 47.—**LACHNOBOLUS** Fries Fl. Scan., 356 (1835), emended (λάχνη wool, βόλος a casting). Sporangia sessile, clustered ; sporangium-wall single, membranous, somewhat persistent, not thickened with angular granules ; capillitium

a loose inelastic network of cylindrical threads, with thickenings in the form of closely set warts.

1. **L. congestus** Lister Mycetozoa, ed. 2, 246 (1911) (heaped). Plasmodium white or rosy. Sporangia subglobose, sessile, clustered and heaped, 0·5 to 0·8 mm. diam., pale copper-colour fading to ochraceous, shining; sporangium-wall membranous, firm, papillose, pinkish or ochraceous. Capillitium a network of freely-branching flaccid pink or ochraceous-yellow threads, irregular in width varying from 2 to 8 μ diam., closely and equally studded with prominent warts and attached at numerous points to the sporangium-wall. Spores in mass pale pink, fading to yellow, faintly and minutely warted, and with a few scattered stronger warts, 6 to 8 μ diam.—*Physarum congestum* Somm. Fl. Lapp., 241 (1826). *Arcyria circinans* Fr. Stirp. Femsj., 83 (1827) ? *A.* (*Lachnobolus*) *congesta* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 4, xvii. 140 (1876). *A. Hariotii* Mass. Mon., 155 (1892). *Perichaena congesta* Fr. Syst. Myc., iii. 192 (1829). *Licea congesta* Wallr. Fl. Crypt. Germ., ii. 345 (1833). *Lachnobolus circinans* Fr. Summ. Veg. Scand., ii. 457 (1849) ? Rost. Mon., 282; Lister Mycetozoa, 194. *L. Sauteri* Rost. in Fuckel Symb. Myc., Nachtr. 76 (1873). *L. incarnatus* Schroet. in Cohn Krypt. Fl. Schles., iii. 1, 110 (1885); Mass. l.c., 138.

Pl. 183.—*a*. sporangia; *b*. capillitium and spores with fragment of sporangium-wall (England).

The sporangia of this species are often heaped together to form large hemispherical clusters 5 to 8 mm. across and 3 to 5 mm. thick; around the larger groups a few isolated sporangia are usually scattered. When freshly formed their colour is pale copper-colour, but this soon fades to dull ochraceous-yellow. The description of *Perichaena congesta* (Somm.) Fr. applies fairly well to the present species. Fries's account of *Arcyria* (*Lachnobolus*) *circinans*, with its large rusty-red sporangia, fugacious sporangium-walls, rust-coloured spores, and compact globose masses of brown capillitium, is not so appropriate, and may possibly refer to a stunted form of *A. ferruginea*; but in the absence of the type this must remain conjectural.

Hab. On dead wood: occurring in Britain in summer and autumn, not common; recorded from Somerset, Warwickshire, Surrey, Essex, Nottinghamshire, Cheshire, Yorkshire, Cumberland, and Elginshire; widely distributed in Europe but nowhere common.

Genus 48.—**PERICHAENA** Fries Symb. Gaster., 11 (1817) (Gr. gaping). Sporangia subglobose, sessile or forming plasmodiocarps, rarely shortly stalked; sporangium-wall usually of two layers, the outer thickened with angular granules which are exceptionally absent in the upper part, the inner usually membranous; capillitium of branching or simple, tubular, inelastic threads, spinose, minutely warted, or nearly smooth, usually marked with irregular constrictions; spores yellow or brown, minutely warted.

KEY TO THE SPECIES OF *PERICHAENA*.

A. Sporangium-wall firm, double :—

A. Sporangia brown or grey—

Sporangia subglobose or forming plasmodiocarps ; capillitium more or less spinose ; spores 8 to 10 μ diam. 1. *P. chrysosperma*

Sporangia flattened ; capillitium minutely warted, abundant ; spores 10 to 11 μ diam. 2. *P. depressa*

Sporangia flattened, minute, crowded on one plane. 3. *P. quadrata*

Sporangia subglobose ; capillitium warted or nearly smooth, usually scanty ; spores 11 to 14 μ diam. 4. *P. corticalis*

B. Sporangia stalked, purple-red or purple-brown. 5. *P. pulcherrima*

B. Sporangium-wall membranous :—

Sporangia pale umber or buff ; spores 10 μ diam. 6. *P. vermicularis*

Sporangia flesh-coloured ; spores 6 μ diam. 7. *P. microspora*

1. **P. chrysosperma** Lister Mycetozoa, 196 (1894) (χρυσός gold, σπέρμα seed). Plasmodium pale brown, grey or pink. Sporangia scattered, sessile or stalked, subglobose or forming curved or ring-shaped plasmodiocarps, 0·2 to 1 mm. diam., chestnut, red-brown or blackish-brown, dehiscing irregularly or with the wall breaking up into areolae ; sporangium-wall of two layers, the outer thickened with brown granular matter, which either forms a complete crust, or is more or less obsolete ; the inner layer subcartilaginous, pale yellowish-olive, translucent, minutely and faintly papillose. Stalk when present cylindrical, stout, black, 0·1 to 0·7 mm. high. Capillitium abundant, forming a loose network of sparingly branched yellow or buff threads 2 to 4 μ diam., irregularly constricted, studded with scattered spinules or curved spines, 1 to 6 μ long. Spores citron-yellow or buff in mass, minutely warted, 9 to 10 μ diam., rarely 7 to 8 μ.—Torrend Fl. Myx., 90 ; Petch in Ann. Perad., iv. 368. *Ophiotheca chrysosperma* Currey in Quart. Micr. Journ., ii. 240, t. ix, figs. 1–5 (1854) ; Macbr. N. Am. Slime-Moulds, ed. 2, 241. *O. Wrightii* Berk. & Curt. in Journ. Linn. Soc., x. 349 (1869) ; Mass. Mon., 132 ; Macbr. l.c. *O. circumscissa* Mass. l.c., 131. *Trichia circumscissa* Wallr. Fl. Crypt. Germ., ii. 378 (1833) ? *T. Curreyi* Crouan Fl. Finist., 16 (1867). *Arcyria glomerata* Fr. Summ. Veg. Scand., 457 (1849) ? *Cornuvia circumscissa* Rost. Mon., 290

(1875). *C. Wrightii* Rost. l.c., App. 36 (1876). *Hemiarcyria melanopeziza* Speg. in Ann. Soc. Cient. Argent., x. 257 (1881). *Perichaena corticalis* var. *affinis* Lister l.c., ed. 2, 251 (1911). *P. variabilis* var. *pedata* Lister in Journ. Bot., xlii. 139 (1904).

Pl. 184.—*a*, stalked and sessile sporangia; *b*, various forms of capillitium from sporangia on the same piece of bark, with spore and fragment of sporangium-wall.

In Rostafinski's description of the genus *Perichaena* the capillitium is said to be without characteristic thickenings. *P. corticalis*, to which this definition most nearly applies, has the capillitium-threads warted and notched, rarely smooth, while in other species of the genus the threads are never smooth, but are marked with minute warts, spinules, or spores. In *P. chrysosperma* there may be considerable difference in the amount of roughness of the capillitium in a single development, some of the sporangia may have almost smooth threads marked only with a few minute scattered spines, other sporangia have short spines 2·5 μ long; others have the threads studded with long curved spines 5 to 6·5 μ long. The type of *Ophiotheca chrysosperma* Currey (B.M. 308) has the capillitium marked with spines 1 to 4 μ long. The type of *Cornuvia Wrightii* Rost. from Cuba (B.M. 699) shows sporangia similar in all respects to Currey's gathering. From the original account of *Trichia circumscissa* Wallroth it is probable that the specimen described was not the present species, in which dehiscence is never 'circumscissile', but *Perichaena depressa*; the specific name given by Currey is therefore adopted. Among a fine series of gatherings of this species made by Mr. K. Minakata in Japan, both large and small, stalked and sessile sporangia occur side by side with plasmodiocarp forms; one growth on the bark of a living apricot tree (*Prunus Armeniaca*) is unusual in having the sporangium-walls rough with prominent clustered deposits of refuse-matter, similar to those of *Hemitrichia minor* var. *pardina*, with which species it happened to be associated. In the light of these varied gatherings it is clear that the stalked form named *P. vermicularis* var. *pedata* in the second edition of this book, should be referred to the present species (Journ. Bot., lvii. 111 (1919)). *P. corticalis* var. *affinis* Lister appears to be a form of the present species with rather firm capillitium marked with small scattered spines and warts.

Hab. On dead wood, *Cycas* leaves, &c., or on the trunks of living trees, or, in Ceylon, on elephant dung: not common in Britain, recorded from Devon, Dorset, Surrey, Bedfordshire, Norfolk, Yorkshire, and Aberdeen; also from Germany, Switzerland, Bohemia, Portugal, Ceylon, Japan, West Indies, and Brazil; abundant in the United States.

2. **P. depressa** Libert Pl. Crypt. Ard., fasc. iv, no. 378 (1837) (flattened). Plasmodium milky-white. Sporangia sessile, crowded, polygonal from mutual pressure, flattened, 0·5 to 1 mm. diam., rarely forming short branching plasmodiocarps, purple-brown, red-brown, buff or grey, dehiscing with a well-defined flat lid; sporangium-wall of two layers, the outer cartilaginous, charged with brown granular matter, often intermixed with angular crystals of oxalate of lime, more or less combined with the membranous smooth inner layer. Capillitium an abundant web of branched slender yellow threads, 1·5 to 2·5 μ diam., minutely warted or marked with regular close-set constrictions at intervals of 0·5 to 1 μ, and with irregular expansions. Spores golden-yellow, minutely

warted, 8 to 12 μ diam.—Rost. Mon., 292; Mass. Mon., 114; Macbr. N. Am. Slime-Moulds, ed. 2, 242. *Stegasma depressum* Corda Icon., v. 58, t. iii, fig. 34 (1842). *S. australe* Cesati in Hedw., xiii. 186 (1874). *Perichaena artocreas* Berk. & Rav. in Grev., ii. 68 (1873). *P. irregularis* Berk. & Curt. in Grev., ii. 68. *P. marginata* Berk. & Br. in Journ. Linn. Soc., xv. 84 (1876) (*non* Schwein). *P. australis* Berl. in Sacc. Syll., vii. 422 (1888); Mass. l.c., 119. *P. applanata* Mass. l.c., 116 (1892). *Hemiarcyria applanata* Cooke & Mass. in Grev., xvi. 20 (1887). *Ophiotheca irregularis* Mass. l.c., 132.

Pl. 189.—*a*. sporangia; *b*. capillitium and spores with a fragment of the double sporangium-wall; *c*. capillitium and spore.

This species is distinguished from *P. corticalis* by the flattened sporangia and smaller spores. The type of *P. applanata* Mass., from Brisbane (K. 153), is characterized by the outer layer of the sporangium-wall having a superficial crust of angular crystals of lime, which gives the sporangia a lilac-grey colour; in all other respects it agrees with the present species in which deposits of lime on the sporangium-wall are of frequent occurrence. The type of *P. artocreas* Berk. & Rav. from South Carolina (K. 1027 and B.M. 697) is also *P. depressa*; it has abundant capillitium, and spores measuring 8 to 10 μ; the sporangia are polygonal, depressed, and pale brown. The type of *P. irregularis* Berk. & Curt. from South Carolina (K. 1706) is typical *P. depressa*. The type of *Stegasma australe* Ces. from Naples (B.M. 1034) is in imperfect condition, but it appears to be the present species from the many broken pieces of minutely warted capillitium, and the spores, which measure 10 to 11 μ diam. *Stegasma pallida* Ces. (in Atti Accad. Sc. Fis. Mat., viii. 12, (1879)) from Borneo may possibly be a form of *P. depressa*, but the description is too brief to be instructive.

Perichaena Krupii Racib. (in Hedw., xxviii. 124 (1889)) is described as having solitary chestnut-brown globose depressed sporangia or flat creeping plasmodiocarps dehiscing by a lid; capillitium forming a dense web of nearly simple closely warted threads, 0·3 to 1·5 μ diam., connected with the sporangium-wall by many slender attachments; spores brownish-yellow, minutely warted, 7 to 8·5 μ diam.—In some respects this description applies to a form of *P. depressa* with very slender capillitium; on the other hand, if the capillitium threads were not tubular but solid, the species might possibly be referred to the genus *Dianema*.

Hab. On dead bark and wood, rarely on decaying evergreen leaves: not uncommon in the British Isles, and widely distributed in temperate and tropical regions.

3. **P. quadrata** Macbr. in N. Am. Slime-Moulds, ed. 2, 243 (1922) (square). Plasmodium ? Sporangia sessile, crowded, depressed, polygonal by mutual pressure, reddish-brown or red with a violet gloss, 0·1 to 0·4 mm. diam.; sporangium-wall breaking in a circumscissile way, cartilaginous, orange-brown with a minutely papillose pale yellow inner layer; the flat lid thickened with granular deposits, capillitium none, or consisting of scanty slender yellow threads sparingly branched, marked with minute warts and spinules. Spores yellow, closely and minutely warted, 9 to 11 μ.

Pl. 220.—*e*. group of sporangia; *f*. piece of sporangium-wall; *g*. spores; *h*. spore and fragment of inner sporangium-wall.

A specimen from Havana, Illinois, gathered by Mr. H. C. Beardsley, consists of a plate of about three hundred minute closely-connected sporangia, covering an area of 5·4 square millimetres; the spores are orange-yellow, 11 μ diam.; no capillitium is developed. The description of the capillitium-threads given above is taken from Prof. Macbride's book; he quotes, as a synonym for *P. quadrata*, *P. irregularis* Morg. (Journ. Cinc. Soc. Nat. Hist., xvi. 14 (1893)); but the specimen sent us by Morgan under that name is typical *P. depressa*.

Hab. On dead wood.—Pennsylvania, Illinois, Ohio, Missouri.

4. **P. corticalis** Rost. Mon., 293 (1875) (from *cortex* bark). Plasmodium watery-grey. Sporangia crowded or scattered, subglobose, often depressed, ellipsoid, or forming bolster-shaped plasmodiocarps, sessile on a broad or narrow base, rarely shortly stalked, 0·5 to 1 mm. diam., dark purple or purplish-brown, nut-brown, grey or white, dehiscing either horizontally with a convex lid or in broad sinuous lobes; sporangium-wall of two layers, the outer cartilaginous, yellowish-brown, charged with brown granular matter, often intermixed with acicular or angular deposits of oxalate of lime which forms a crystalline covering in grey and white sporangia; inner layer membranous, usually closely combined with the outer. Capillitium often scanty or even wanting, consisting of slender, long or short, branched or simple weak yellow threads, 1·5 to 4 μ diam., irregularly compressed, angled and constricted, minutely warted, or marked with short spines and prominences, rarely smooth, either attached to the sporangium-wall or free. Spores yellow, minutely and closely warted, 10 to 14 μ diam.—Mass. Mon., 115; Macbr. N. Am. Slime-Moulds, ed. 2, 245. *Mucor Lycoperdioides* Scop. in Ann. Nat. Hist., iv. 151, t. 1, f. 11 (1772) ? *Lycoperdon corticale* Batsch Elench. Fung., 155 (1783). *Sphaerocarpus sessilis* Bull. Champ., 132, t. 417, fig. 5 (1791). *Trichia fusco-atra* Sibth. Fl. Oxon., 407 (1794). *T. gymnosperma* Pers. Obs. Myc., i. 63, t. vi, figs. 1, 2 (1796). *T. circumscissa* Schrad. Nov. Pl. Gen., 19 (1797). *Licea circumscissa* Pers. Syn. Fung., 196 (1801). *L. nitens* Schwein. in Trans. Amer. Phil. Soc., n. ser. iv. 259 (1832) ? *L. quercina* Wallr. Fl. Crypt. Germ., ii. 344 (1833) ? *Physarum luteo-album* Schum. Enum. Pl. Saell., ii. 199 (1803). *Tubulina circumscissa* Poir. in Lam. Encycl., viii. 131 (1804). *Perichaena populina* Fr. Symb. Gast., 12 (1817); Lister Mycetozoa, 198. *P. quercina* Fr. l.c. ? *P. abietina* Fr. l.c., 11. *P. marginata* Schwein. l.c., 258 (1832); Macbr. l.c., 244. *P. vaporaria* Schwein. l.c. ? *P. fusco-atra* Rost. Mon., 294 (1875). *P. Rostafinskii* Karst. in Bidr. Känn. Finl. Nat. (1879) 130. *P. microcarpa* Schroet. in Cohn Krypt. Fl. Schles., iii. 1, 108 (1885) ? *P. canoflavescens* Raunk. in Bot. Tidssk. (1888) 54 ? *P. nitens* Raunk. l.c., 55 ? *P. ochrospora* Peck in Rep. N.Y. Mus. Nat. Hist., 156 (1900) ? *Cornuvia dictyocarpa* Krupa in

Cosmos, 377 (1886) ? *Oligonema Broomei* Mass. in Journ. R. Micr. Soc. (1889) 346 ; Mass. Mon., 172. *O. nitens* Mass. l.c., 133 ?

Var. **liceoides** Lister Mycetozoa, ed. 2, 251 (1911) (*Licea*). Sporangia subglobose or bolster-shaped, nut-brown or shining yellow, minute, 0·1 to 0·5 mm. diam., dehiscing irregularly ; granular deposits of outer sporangium-wall scanty or wanting ; capillitium often scanty or none, rarely forming a network of nearly smooth threads ; spores 10 to 15 μ diam.—*Perichaena liceoides* Rost. Mon., 295 ; Mass. Mon., 118. *Licea pannorum* Cienk. (*non* Wallr.) in Pringsh. Jahrb. Bot., iii. 407 (1863). *Lachnobolus pygmaeus* Zukal in Oester. Bot. Zeitschr., xliii. 136 (1893).

Pl. 186.—*a*. sporangia ; *b*. capillitium and fragment of sporangium-wall ; *c*. capillitium and spore (England).

This species shows great variation in the shape and colour of the sporangia, and in the abundance of the capillitium. In large developments from one plasmodium every variety of form is sometimes represented from broad plasmodiocarps to globose and substipitate sporangia, and the colour may range from deep purple to grey. When the colour is pure white, the sporangium-wall has an outer covering of crystalline deposits of lime without the intermixture of brown granules. The capillitium is subject to much variation according to the season of the year and other causes. In a gathering made at Lyme Regis in the autumn, the capillitium was scanty, forming a net of rugged coarsely warted threads 2 to 4 μ diam. with a few scattered free threads ; in the following spring another growth on the same pieces of bark had sporangia of a similar shape and colour, but with a more abundant capillitium forming a freely branching slender network of minutely warted threads 1 to 1·5 μ diam., scarcely differing from that of *P. depressa*, the larger spores being the chief distinguishing character. The specimens named *P. fusco-atra* in the collections differ in no respect from *P. corticalis*, and cannot be held as specifically distinct. The type of *Oligonema Broomei* Mass. from Warleigh (B.M. 364) is typical *P. corticalis* with characteristic branching capillitium-threads marked with irregular swellings and spinules, and with minutely and closely warted spores 14 to 15 μ diam. Dr. Jahn has courteously sent me part of a growth which he describes under the name '*P. pedata* Lister ? ' ; it consisted of about 30 sporangia and appeared on a culture of rabbit dung ; some of the small sporangia which vary from 0·1 to 0·6 mm. diam. have black stalks, others are sessile ; the capillitium is very scanty, the spores measure 11 to 14 μ ; it appears to be a form of the present species, in which stalked sporangia are sometimes met with (see Ber. Deutsch. Bot. Ges., xxxvi. 667, t. xviii, figs. 14–16 (1919)). The var. *liceoides* is a minute form, with translucent sporangium-wall and capillitium often scanty or absent, usually found on the dung of deer, rabbits, &c. It is described by Cienkowski as *Licea pannorum*, l.c., and is given by Rostafinski as the type of a new species, *Perichaena liceoides*, characterized by the scanty capillitium of free threads and the spores measuring 9 to 10 μ ; Zopf, on the other hand, quotes it as a synonym for *P. corticalis* ; and this view is confirmed by the not unfrequent occurrence of forms of the latter species with scanty or no capillitium, and spores measuring from 10 to 12 μ. The type of *Lachnobolus pygmaeus* Zukal, from Carinthia, is the same variety ; preparations courteously submitted to us by the late Prof. F. v. Höhnel show minute sporangia, 0·1 to 0·2 mm.

diam., with walls free from angular deposits, and with scanty, irregular capillitium; the spores in one sporangium measure 10 to 12 μ, and in another 13 to 15 μ. A specimen of var. *liceoides* from Denmark, on the dung of fallow deer, sent us by Dr. Jahn, has shining orange-yellow sporangia, 0·1 to 0·4 mm. diam., with translucent membranous walls, and capillitium forming a close network with many rounded free ends; a similar form was found by Mr. N. G. Hadden, in January 1919, near Porlock, Somerset, on hedge clippings. The sporangia of *P. corticalis* often closely resemble those of *Trichia contorta* and *Hemitrichia Karstenii*, from which they may be distinguished by the capillitium being more slender and showing no trace of spiral markings.

Hab. On dead bark and wood: abundant in the British Isles in autumn and winter; widely distributed in temperate and tropical regions, not common in the United States: var. *liceoides* on twigs and dung of rabbits, &c.; Somerset, Germany, Denmark, Austria, and Florida.

5. **P. pulcherrima** Petch in Ann. Perad., iv. 305 (1909) (very beautiful). Plasmodium ? Sporangia scattered and stalked, or clustered and almost sessile on an irregular hypothallus, globose, 0·5 mm. diam., glossy purple-red or purple-brown; sporangium-wall dehiscing irregularly, of two closely adhering layers, the outer rather stout, purplish-red, with scattered granular deposits, the inner hyaline. Stalks 0·1 to 0·3 mm. high, red-brown, furrowed, containing granular refuse-matter. Capillitium a loose flaccid network of reddish-brown threads, 3 to 4 μ diam., with few rounded free ends and few attachments to the sporangium-wall; thickenings in the form of scattered warts and straight or curved spines 1 to 2 μ long. Spores purplish-brown in mass, when magnified pale reddish-brown, closely spinulose, 15 to 17 μ diam.—Petch l.c., 370.

Pl. 188.—*a*. cluster of sessile sporangia; *b*. capillitium and spores with fragment of sporangium-wall; *c*. spores, and capillitium showing attachment of threads to sporangium-wall; *d*. spore and capillitium (Ceylon).

This species was found on the branches of *Theobroma Cacao* and *Erythrina lithosperma* by Mr. Petch at Ukuwela, Ceylon, November 1906; he obtained a further development a few days later from the same branches after keeping them in a moist chamber. In some cases the sporangium-wall is marked with a reticulation corresponding to the impression of the spores. *P. pulcherrima* is distinguished from other species of the genus by the colour of the sporangia, which resembles that of *Physarum pulcherrimum* Berk. & Rav., and by the comparatively stout brown capillitium-threads.

Hab. On dead wood.—Ceylon.

6. **P. vermicularis** Rost. Mon., App. 34 (1876) (*vermiculus* a little worm). Plasmodium watery-white, yellowish-white, or rose-red. Sporangia scattered, sessile, globose on a narrow base, 0·5 mm. diam., or forming slender curved or net-like plasmodiocarps, ochraceous-yellow, pale umber or greyish; sporangium-wall of two layers, the outer more or less charged with dark granules and occasionally with angular crystals of lime, closely combined with the membranous papillose inner

layer ; in some cases an outer layer is not distinguishable in the upper part of the sporangium. Capillitium a profuse network of sparingly branched yellow threads, 2 to 4 μ diam., rough with minute scattered warts and irregular constrictions. Spores yellow, minutely warted, 10 to 15 μ diam.—*Physarum vermiculare* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 257 (1832). *Ophiotheca pallida* Berk. & Curt. in Journ. Linn. Soc., x. 350 (1869). *O. umbrina* Berk. & Curt. in Grev., ii. 68 (1873). *O. vermicularis* Mass. Mon., 134 (1892) ; Macbr. N. Am. Slime-Moulds, ed. 2, 240. *O. reticulata* Mass. l.c., 133. *Licea reticulata* Berk. & Br. in Journ. Linn. Soc., xiv. 86 (1873). *Perichaena variabilis* Rost. Mon., 295 (1875) ; Lister Mycetozoa, 199 ; Petch in Ann. Perad., iv. 370. *P. Friesiana* Rost. l.c., 296. *P. reticulata* Rost. l.c., App. 35. *P. confusa* Mass. l.c., 117.

Pl. 187.—*a*. sporangia ; *b*. capillitium ; *c*. capillitium and spores with fragment of sporangium-wall.

The yellow form of this species is not uncommon in England and is widely distributed throughout Europe ; it corresponds exactly with the type of *Physarum vermiculare* Schwein. from North Carolina (K. 1671). The type of *Ophiotheca umbrina* Berk. & Curt. from North Carolina, no. 413 (K. 1705), was originally published as *Ophiotheca pallida* Berk. & Curt. It is a pale umber plasmodiocarp form, agreeing in the structure of the sporangium-wall, capillitium, and spores with the English gatherings. Part of this type was sent by Fries to Rostafinski, who described it as '*Perichaena Friesiana*' (Rost. Mon., 269) ; in the appendix to his Monograph, however, *Ophiotheca umbrina* B. & C. is placed as a synonym for *P. variabilis* Rost. ; it was probably by an oversight that Rostafinski still retained *P. Friesiana* as a distinct species (Mon., App. 35). A specimen of *P. vermicularis* from New Jersey from Ellis, no. 726, N. Am. Fungi (K. 990), originally named *P. Friesiana*, and then *O. umbrina*, and one from Lyme Regis represent types of a new species, *P. confusa* Massee. The type of *Licea reticulata* Berk. & Br., from Ceylon (B.M. slide), is also the present species ; the sporangia consist of minute pale umber net-like plasmodiocarps, some of which have very scanty capillitium, in others it is more abundant and of the usual minutely warted type ; the spores are closely and minutely warted and measure 11 to 15 μ. In all these specimens the inner layer of the sporangium-wall is distinctly papillose, a character by which this species of *Perichaena* is distinguished from all others. *P. vermicularis* occurs in some abundance in alpine regions on and within hollow decayed herbaceous stems, and developing from rose-red plasmodium. In South Nigeria Mr. C. O. Farquharson found it forming extensive net-like plasmodiocarps on dead bark and old cotton bolls.

Hab. On dead leaves, twigs, herbaceous stems and bark : widely distributed in North Temperate regions, recorded also from Ceylon, South Nigeria, and Malaya.

7. **P. microspora** Penzig & Lister in Penzig Myx. Buit., 76 (1898) (*μικρός* small, *σπέρμα* seed). Plasmodium ? Sporangia forming slender, short, long or net-like plasmodiocarps, 0·25 to 0·35 mm. diam., salmon-pink, glossy ; sporangium-wall membranous, single, yellowish, smooth, thickened with

deposits of granular matter towards the base only. Capillitium a loose network of slender fragile yellowish-pink threads, 1·5 to 2 μ diam., marked with minute spines, regularly constricted at intervals of 1 to 2 μ, more or less attached to the sporangium-wall. Spores in mass pinkish-yellow, when magnified pale yellowish, closely and minutely spinulose, 6 to 8 μ diam.—Petch in Ann. Perad., iv. 369.

Pl. 185.—*a*. plasmodiocarps ; *b*. capillitium and spores with fragment of sporangium-wall (Java).

Hab. On dead leaves and twigs.—Ceylon (B.M. 3142) ; Java (B.M. slide).

Genus 49.—**MINAKATELLA** G. Lister in Journ. Bot., lix. 92 (1921) (Kumagusu Minakata, the discoverer of the species). Sporangia sessile, clustered, more or less united into an aethalium. Capillitium forming a coil of nearly simple smooth flattened tubular threads. Spores spinulose.

1. **M. longifila** G. Lister l.c. (long threads). Plasmodium ? Sporangia sessile, subglobose, 0·3 to 0·5 mm. diam., forming small heaped clusters or more or less confluent to form an aethalium 2 mm. across, dull brick-red, with shining iridescent membranous walls ; where the sporangia are in contact the walls may be imperfectly developed and reduced to irregular reddish strands and pouches. Capillitium a coil of smooth slender compressed pale red threads, 1·5 to 3 μ diam., sparingly branched and with a few free bulbous ends ; one side of the thread bordered by a low ridge or wing. Spores in mass dull venetian red, pale red with transmitted light, 10 to 11 μ diam., adhering in clusters of 8 to 14, more distinctly warted on the side facing outward as they lie in the cluster.

Pl. 208.—*a*. cluster of sporangia ; *b*. aethalium ; *c*. capillitium and spores with fragment of aethalium wall ; *d*. spores and fragment of capillitium.

This species was found by Mr. K. Minakata on bark and lichen on the trunk of a living Persimmon tree (*Diospyros Kaki*) near Tanabe, in the province of Kii, Japan, August 1917. The specimen consisted of four clusters of sporangia, two of which were broken and showed a tangle of capillitium-threads. The genus has some affinity with *Perichaena*, but differs in the aethalioid habit and the smooth capillitium.

Hab. On bark.—Japan.

Family III.—Margaritaceae.

Sporangia usually sessile ; sporangium-wall single, rarely of two layers in *Dianema*, smooth, usually translucent ; capillitium consisting of solid threads, either coiled and hair-like, or nearly straight and attached to the sporangium-walls, simple or branching at an acute angle.

KEY TO THE GENERA OF *MARGARITACEAE*.

A. Sporangia dehiscing irregularly :—
Capillitium-threads profuse, coiled. (50) MARGARITA

Fig. 57.—*Margarita metallica* Lister.

a. Two sporangia. Magnified 6 times.

b. Part of a long capillitium-thread, and a spore. Magnified 250 times.

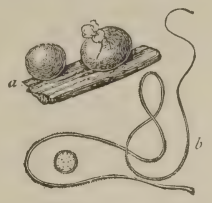


Fig. 57.

Capillitium of nearly straight slender threads attached above and below to the sporangium-wall. (51) DIANEMA

Fig. 58.—*Dianema depressum* Lister.

a. Plasmodiocarp. Magnified twice.

b. Capillitium attached above and below to the walls of the sporangium. Magnified 50 times.

c. Spore. Magnified 560 times.



Fig. 58.

Capillitium-threads marked with spiral thickenings, stout below, penicillate and slender above, attached above and below to the sporangium-wall. (52) PROTOTRICHIA

Fig. 59.—*Prototrichia metallica* Mass.

a. Group of sporangia. Magnified 4 times.

b. Capillitium attached above to a fragment of the sporangium-wall, and a spore. Magnified 280 times.



Fig. 59.

B. Sporangia dehiscing in lobes ; capillitium-threads with moniliform thickenings. (53) LISTERELLA

Fig. 60.—*Listerella paradoxa* Jahn.

a. Sporangia. Magnified 50 times.

b. Capillitium-thread and spores. Magnified 460 times.

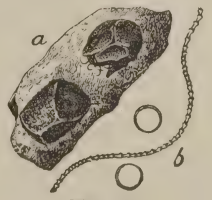


Fig. 60.

Genus 50.—**MARGARITA** Lister Mycetozoa, 203 (1894) (pearl). Sporangia sessile; sporangium-wall translucent; capillitium a profuse coil of hair-like nearly simple solid threads, with indistinct attachments to the sporangium-wall.

1. **M. metallica** Lister l.c. Plasmodium watery-white. Sporangia solitary or clustered, globose, sessile on a narrow base, 0·5 to 1 mm. diam., or pulvinate, pearl-grey or copper-coloured, shining, iridescent; sporangium-wall membranous, single, glaucous or yellowish, translucent. Capillitium a profuse coil of very long elastic flexuose solid grey or yellowish threads, 0·5 to 1 μ diam., increasing in some parts to 2 μ, scarcely branching in normal developments, with few attachments to the sporangium-wall or almost free, marked with a very lax spiral band of minute spinules. Spores in mass pale pinkish-grey, becoming yellowish-buff in age, when magnified nearly colourless, minutely warted, 8 to 13 μ diam.—Meylan in Bull. Soc. Vaud. Sc. Nat., xlvi. 56; Macbr. N. Am. Slime-Moulds, ed. 2, 237. *M. pictoviana* Moore in Proc. Nova Scotia Inst. Sci., xii. 96 (1910)? *Physarum metallicum* Berk. & Br. in Mag. Zool. Bot., i. 49 (1838). *Cornuvia metallica* Rost. Mon., App. 35 (1876).

Var. **plasmodiocarpa** R. E. Fries in Svensk Bot. Tidskr., vi. 800 (1912). Sporangia forming plasmodiocarps.—*Perichaena plasmodiocarpa* Blytt Bidr. K. Norg., Sop. iii. 10 (1892). *P. incarnata* Fr. Syst. Myc., iii. 193 (1829)? *Licea incarnata* Alb. & Schw. Consp. Fung., 109 (1805)? *Lycogala incarnatum* Swartz in Handl. K. Svenska Vet. Acad., 112 (1815)? *M. metallica* var. *intermedia* Meylan in Bull. Soc. Vaud. Sc. Nat., xlvi. 56 (1910).

Pl. 196.—*a*. two forms of sporangia on wood; *b*. sporangium on leaf; *c*. capillitium with fragment of sporangium-wall and spores; *d*. capillitium and spore.

The sporangia formed on leaves are usually solitary and spherical; those on wood are often clustered, and either subglobose or in the form of short or elongated plasmodiocarps. The beautiful pearly or pinkish-grey of the freshly gathered spores fades to dull ochraceous-yellow after the specimen has been kept for some time in the herbarium. If developed under unfavourable conditions, the capillitium often consists in part of stout irregular branching threads showing numerous attachments to the sporangium-wall; the sporangia then bear considerable resemblance to cold-weather forms of *Prototrichia metallica*, to which the present species is undoubtedly allied. The var. *microspora* Meyl. (l.c., liii. 462) has rather small spores, 7 to 8 μ diam. The description of *Licea incarnata* Alb. & Schw., with flesh-coloured iridescent sporangia, hemispherical, oval, 'sub-linear' or flexuose in shape, and extremely fragile sporangium-walls, applies to some forms of the present species; in the absence of the type this determination must remain conjectural.

Hab. On dead wood and decaying evergreen leaves: not uncommon in the British Isles in autumn and winter; widely distributed throughout Europe and the western United States; recorded also from the western Himalayas, Malaya, Japan, South Chili, Nova Scotia, New Hampshire.

Genus 51.—**DIANEMA** Rex in Proc. Acad. Nat. Sci. Phil., 1891, 397 (Gr. something spun). Sporangia sessile, or forming plasmodiocarps; sporangium-wall membranous or cartilaginous; capillitium consisting of nearly straight slender threads, attached above and below to the sporangium-wall.

KEY TO THE SPECIES OF *DIANEMA*.

A. Sporangium-wall translucent, membranous; spores free:—

Capillitium-threads nearly simple, attached to the sporangium-wall by short branches. 1. *D. Harveyi*

Capillitium-threads branching freely above. 2. *D. nivale*

Plasmodiocarps broad; capillitium-threads rigid, attached by acuminate extremities to the sporangium-wall. 3. *D. depressum*

Plasmodiocarps slender; capillitium scanty; spores clustered. 4. *D. repens*

B. Plasmodiocarps with cartilaginous walls; spores clustered. 5. *D. corticatum*

1. **D. Harveyi** Rex l.c. (F. L. Harvey, the discoverer of the species in the State of Maine). Plasmodium white. Sporangia solitary or in small clusters, sessile, subglobose, hemispherical or cushion-shaped, flattened above, 0·5 to 2 mm. diam., 0·35 to 1 mm. in height, sometimes elongated and bent into an irregular horseshoe shape, dull red or gold-bronze, shining; sporangium-wall membranous, thin, translucent, pale purplish or olivaceous, marked with the persistent ends of the capillitium when the rest of the threads have broken away. Capillitium of numerous slender, brownish-yellow threads, 1·5 to 2 μ diam., simple or sparingly branched and anastomosing, often dividing into slender branchlets at their origin or insertion, nearly parallel, straight or flexuose, running from the base to the upper wall of the sporangium. Spores in mass brick-red, at length brownish-yellow, when magnified pale yellow, minutely warted, 8 to 10 μ diam.—Macbride N. Am. Slime-Moulds, ed. 2, 238; Torrend Fl. Myx., 84.

Pl. 191.—*a*. sporangia; *b*. capillitium showing attachment above and below to the sporangium-walls, with spores; *c*. spore.

This appears to be distinctly a winter species in Britain; Dr. W. C. Sturgis has gathered it in August in Colorado; it usually forms rather small colonies. It has been found repeatedly in Devonshire and Yorkshire, and the Rev. W. Cran reports it as 'abundant' in some seasons near Aberdeen. The fragile capillitium easily breaks away leaving short branchlets attached to the sporangium-wall.

Hab. On dead wood, occurring in Britain from November till March.—

Devonshire, Somerset, Worcestershire, Bedfordshire, Yorkshire, Aberdeenshire ; and in the States of Maine and Colorado.

2. **D. nivale** G. Lister (belonging to snow). Plasmodium ? Sporangia sessile or shortly stalked, solitary or in small clusters, subglobose or pulvinate, 1 to 1·5 mm. diam., greyish-pink, shining with iridescent green or coppery reflections ; sporangium-wall membranous, thin, translucent, pinkish-grey. Stalk short, pale, enclosing granular matter 0·1 to 1 mm.? high. Capillitium of abundant pinkish-grey, straight or flexuose threads radiating from the thickened floor of the sporangium, branching and anastomosing, attached by slender branchlets to the outer walls ; stouter below, becoming very slender in the upper part. Spores in mass pale greyish-pink, minutely and closely warted, 8 to 12 μ diam.—*Lamprodermopsis nivalis* Meylan in Bull. Soc. Vaud. Sc. Nat., xlvi. 56 (1910). *Dianema Andersonii* Macbr. N. Am. Slime-Moulds, ed. 2, 239 (1922) ?

This species differs from *L. Harveyi*, which it closely resembles, in the more freely branching and abundant capillitium radiating from the thickened base of the sporangium which may be extended into a short stalk, like that often present in *Prototrichia metallica* : the sporangium-wall is not marked with persistent ends of capillitium when the remainder of the threads have broken away. It was discovered by M. Ch. Meylan on dead grass stalks, close to melting snow in May 1909, in two localities, 1,200 and 1,280 m. alt. respectively, near Ste. Croix in the Swiss Jura. In March 1912 the Rev. W. Cran found the same forms on ash twigs near Skene, Aberdeenshire. *D. Andersonii* Macbr., from British Columbia, is described as resembling *D. Harveyi* but having capillitium branching once or twice and arising from the thickened base of the sporangium-walls, characters appropriate to *D. nivale*.

Hab. On turf in alpine regions and on twigs.—Aberdeenshire, Jura Mountains.

3. **D. depressum** Lister Mycetozoa, 204 (1894) (flattened). Plasmodium white or rosy red. Sporangia solitary or clustered, forming sessile flattened pulvinate plasmodiocarps, 2 to 10 mm. wide, about 0·3 mm. thick, shining violet when immature, glossy and grey-brown when mature ; sporangium-wall membranous, smooth or minutely reticulated, translucent, yellowish- or lilac-grey, marked on the inner side with the persistent ends of the capillitium when the rest of the threads have fallen away. Capillitium profuse, consisting of pale yellowish-grey straight rigid slender threads, 0·5 to 2 μ thick, minutely papillose on one side, united into numerous small pencil-like clusters, anastomosing above and below, the ends of the pencils attached to the sporangium-wall by suddenly acuminate tips, at length breaking away in an elastic web. Spores in mass lilac-grey or drab, when magnified pale yellowish-grey, closely reticulated over the greater part of the surface with raised bands, forming a border 0·5 to 1 μ broad, the remaining part marked with broken or very loose

reticulation, 6 to 9 μ diam.—*Cornuvia depressa* Lister in Journ. Bot., xxix. 264, t. 311, fig. 2 (1891).

Pl. 190.—*a*. sporangium; *b*. spores and capillitium showing attachment of the threads to the base and upper wall of the sporangium; *c*. capillitium and spores.

The sporangium-wall is usually single, but sometimes has an outer purplish granular layer clothing the membranous layer. In some irregular developments the capillitium-threads are in part united into sheaves by many short transverse branchlets; in others the pencil-like tufts of capillitium are attached to the lower sporangium-wall by stout expanding bases, and the threads are marked with irregular thickenings and knots.

Hab. On dead wood and sticks of oak, ash, &c., winter and early spring: widely distributed in England; recorded from Elginshire, Sweden, Portugal, and Japan.

4. **D. repens** G. Lister & Cran (creeping). Plasmodium rosy red. Sporangia scattered, forming straight or curved, simple or branching plasmodiocarps, 0·3 mm. wide or more, dull purplish-brown, with a wrinkled surface; sporangium-wall membranous, almost colourless above, pale purplish-brown below, with a thin outer layer of dark granular refuse-matter; capillitium of rather scanty brown threads, 2 to 3 μ diam., broader at the base, branching and anastomosing, with wide membranous expansions, more slender above. Spores in mass rosy pink, adhering in clusters of 4 to 12, globose or oval, minutely warted on the outer side, 10 to 11 μ diam.

This inconspicuous species has been found on hepatics and lichen on living trees in two localities: in Aberdeenshire by the Rev. W. Cran in November 1912, and near Porlock, Somerset, by Mr. N. G. Hadden in December 1920. It is nearly allied to *D. corticatum*, differing in the slender plasmodiocarps, the membranous sporangium-wall, and the coarse capillitium-threads; the irregular character of the latter may be due partly to weather conditions during development.

Hab. On lichens and hepatics on living trees, in winter.—Somerset, Aberdeenshire.

5. **D. corticatum** Lister Mycetozoa, 205 (1894) (having a bark). Plasmodium pink. Sporangia either hemispherical, 1 mm. diam., or more often forming elongated, ring-shaped or net-like plasmodiocarps 3 to 30 mm. long, shining or opaque, chestnut- or purple-brown: sporangium-wall ochraceous-olive, composed of two layers, the outer cartilaginous, densely granular, the inner membranous. Capillitium somewhat sparse, rarely none, consisting of simple or acutely branching slender pale brown threads, 0·5 to 1·5 μ diam., nearly smooth or marked with a single prominent spiral band, or for a short distance with three spiral bands, often with scattered bead-like thickenings; the threads are attached above and below by very slender extremities to the sporangium-wall. Spores dull pink in mass, nearly colourless when highly magnified, subelliptical, adhering in clusters of 4 to 6, minutely warted on the outer side, 10 to 15 $\mu \times 8$ to

10 μ diam.—Torrend Fl. Myx., 84; Macbr. N. Am. Slime-Moulds, ed. 2, 239.

Pl. 193.—*a*. plasmodiocarp; *b*. capillitium attached to fragment of sporangium-wall, and clustered spores; *c*. capillitium and spores (Norway).

This species was found first on rotten planks at Sande, Norway, September 1894, associated with *Licea flexuosa*, to which and also to *Enteridium liceoides* it bears a superficial resemblance. It differs from both in the more glossy plasmodiocarps and the more lilac or pink colour of the spores.

Hab. On dead coniferous wood.—Yorkshire, Northumberland, Inverness-shire, Aberdeen, Co. Antrim, Scandinavia, Switzerland, Austria, Queensland, Colorado, Alberta, Quebec.

Genus 52.—**PROTOTRICHIA** Rostafinski Mon., App. 38 (1876) (πρῶτος first, and *Trichia*). Sporangia sessile or stalked; capillitium-threads rising from the base of the sporangium as stout strands marked with spiral thickenings, dividing above into pencils of slender branches attached at the tips to the upper part of the sporangium-wall.

1. **P. metallica** Mass. in Journ. R. Micr. Soc. (1889) 350 (metallic). Plasmodium white. Sporangia crowded or scattered, subglobose, 0·5 to 1 mm. diam., sessile on a broad base, or shortly stalked, rarely forming plasmodiocarps, brown or copper-coloured, shining iridescent; sporangium-wall a substantial pale pinkish-brown or glaucous smooth translucent membrane, at length marked on the inner side with the slender persistent ends of the capillitium-threads. Stalk cylindrical, 0·1 to 0·4 mm. long, 0·15 mm. thick, yellowish-brown, enclosing dense granular matter. Capillitium rising from the base of the sporangium in the form of numerous red- or olive-brown stout solid threads marked with two to four spiral bands, branching repeatedly above to form a pencil of slender branchlets attached by their extremities to the sporangium-wall. Spores pink or pale pinkish-brown, minutely warted, 9 to 11 μ diam.—Mass. Mon., 127; Macbr. N. Am. Slime-Moulds, ed. 2, 258. *Trichia metallica* Berk. in Hooker Fl. Tasm., 268 (1859). *T. flagellifera* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 3, xviii. 56 (1866). *Prototrichia flagellifera* Rost. Mon., App. 38 (1876); Mass. l.c.; Lister Mycetozoa, 206; Macbride l.c., ed. 1, 199. *P. elegantula* Rost. l.c., 39, fig. 246. *P. cuprea* Mass. in Journ. R. Micr. Soc., 1889, 351; Mass. Mon., 129. *P. chamaeleontina* Mass. l.c., 130, in part. *P. Schroeteri* Meylan in Bull. Soc. Vaud. Sc. Nat., liii. 462 (1921).

Pl. 195.—*a*. sporangia; *b*. stalked sporangium; *c*. capillitium with fragment of sporangium-wall and spores; *d*. irregular capillitium with faint spirals; *e*. spore (England).

This species is very sensitive to changes of temperature and weather. In perfect development the strands of the capillitium are deep red-brown, marked with conspicuous close spiral bands, dividing above into a brush of more slender straight threads; the spores are pale pinkish-brown, and

distinctly warted. Where the development has been checked by cold or dry weather, the threads are pale olive or almost colourless and divide into irregular or lax branches marked with indistinct spirals; or the spirals may be wanting or replaced by broad or narrow rings; associated with this form the spores are paler, and faintly warted or nearly smooth. In cultivations where the plasmodium is injured by being brought indoors, the capillitium often forms very irregularly, the threads anastomosing with broad and flat expansions and showing no appearance of spirals. Gatherings of this form obtained by Mr. Camm from Smethwick, Stafford, after cold weather, are described by Massee as a distinct species *Prototrichia chamaelcontina*. Little now remains of the type of *Trichia metallica* Berk. from Tasmania (K. 1741); but the specimen is referred to *Prototrichia flagellifera* by Rostafinski, who saw it in good condition, and by the rule of priority Berkeley's earlier specific name must be retained. The type of *Trichia flagellifera* Berk. & Br. from Badminton (B.M. 333) is the form of the present species with olivaceous capillitium marked with faint spirals, and having nearly smooth spores. The type of *P. elegantula* Rost., from Sweden (K. 1743), is a more perfect development with the spirals well marked and with distinctly warted spores. *P. cuprea* Mass., from Scarborough and Carlisle (K. 1744, 1745), is a similar form with minutely warted spores. *P. Schroeteri* Meylan, from the Swiss National Park, is the stalked form of the present species, with rather irregular capillitium.

Hab. On dead sticks, bark, etc., rarely on living trees.—Not uncommon in the British Isles in the winter months; recorded from Norway, Sweden, Germany, Switzerland, Tasmania; not uncommon in the western United States.

Genus 53.—**LISTERELLA** Jahn in Ber. Deutsch. Bot. Gesellsch., xxiv. 540 (1906) (A. Lister, F.R.S., 1830 to 1908). Sporangia minute, hemispherical, brownish-black, dehiscing in lobes; sporangium-wall membranous; capillitium of very slender threads marked with moniliform thickenings, attached to the sporangium-wall; spores grey.

1. **L. paradoxa** Jahn l.c., 538, t. xxii, figs. 1–7 (Gr. strange). Plasmodium ? Sporangia scattered, sessile, hemispherical or pulvinate on an expanded base, 0·2 to 0·3 mm. diam., dull blackish-brown, marked with shining ridges along the lines of dehiscence; sporangium-wall membranous, purplish-brown, clothed externally with dark granular refuse-matter except along the margins of the four to six lobes of dehiscence. Capillitium scanty, consisting of slender flexuose pale purplish-brown threads, 0·5 μ diam., marked at intervals of 1 to 2 μ with bead-like thickenings 1 μ diam., attached below and perhaps above also to the sporangium-wall. Spores in mass blackish-brown; when magnified faintly spinulose, 7 to 8 μ diam., pale brownish-grey with a thin paler patch of dehiscence.

Pl. 191.—*d*, *e*. sporangia; *f*. capillitium and spores with fragment of sporangium-wall (North Germany).

This minute and inconspicuous species has been found scattered over the stems of 'reindeer moss' (*Cladonia gracilis*) by Herr O. Jaap near both Hamburg and Triglitz in North Germany. In size and external appearance

Listerella paradoxa resembles *Licea minima*, but, as Dr. Jahn points out, the presence of the capillitium completely separates the genus from the *Liceaceae*; he suggests that it should be the type of a new family, the *Listerellaceae*. It is placed here provisionally among the *Margaritaceae*, but its true position is at present uncertain. It may perhaps be allied to *Dianema*, but is distinguished by the regular moniliform markings of the capillitium, and by the dusky colour of the spores.

Hab. On lichen (*Cladonia*) on moorland.—N. Germany.

ERRATA AND ADDENDA

P. 86. For *Diderma arboreum* G. Lister & Petch in Journ. Bot., li. 2 (1913) read *D. Chondrioderma* G. Lister, *nov. comb.*

While these pages were in the press, conclusive evidence has been obtained that *D. arboreum* is the same species as *Chondrioderma Alexandrowiczii* Rost. Mon. 169 (1875), syn. *Didymium Chondrioderma* de Bary & Rost. in Alex. Stroj. &c., 89 (1872), the type of which is in the Strasburg collection. To retain the earliest specific name, a new combination, *Diderma Chondrioderma*, must be adopted, and *D. arboreum* becomes a synonym.

P. 175. Add to synonyms of *Cribraria tenella*: *C. colossae* Speg. in Anal. Mus. Nac. Buen. Aires (xii) 258 (1909) ?.

Add to notes on *C. tenella*:—From the description of *C. colossae* Speg. it seems possible that this may be an unusually long-stalked form of the present species.

P. 193. After *Enteridium antarcticum* Speg. in Bol. Acad. Nac. Cienc. Cord. xi, for 363, read 277.

Plate 206. For *Diderma arboreum* G. Lister & Petch, read *Diderma Chondrioderma* G. Lister.

LIST OF SPECIES TO BE DISCARDED

on account of their either being imperfectly described or not belonging to the Mycetozoa.

Arcyria carnea Wallr. Fl. Crypt. Germ., ii. 383 (1833), a fungus, *Stilbum* sp. (?)

A. denudata Fr. Nov. Symb. Mycol. 135 (1851), doubtful; possibly *Arcyria incarnata* Pers.

A. ramulosa Wigand in Pringsh. Jahrb. wissensch. Bot., iii. 43 (1863) = *Trichia ramulosa* Rudolphi; probably a fungus.

A. viridis Zollinger in Flora, xxx. 33 (1847), apparently not one of the Mycetozoa.

Badhamia carnea Oudemans in Nederl. Kruidk. Arch., ser. 2, i. 166 (1871), a fungus, *Tubercularia* sp. (?)

B. fulvescens Cooke in Grev., iv. 69 (1875), is a fungus, probably one of the *Perisporiaceae* (teste Cooke).

B. irregularis Cooke & Ellis in Grev., v. 89 (1876), description insufficient.

Cionium carolinense Spreng. Syst. Veg., iv. 529 (1827), a fungus, *Cauloglossum transversarium* Fr., teste Fries.

C. senegalense Spreng. l.c., a fungus, *Podaxon calyptratus* Fr., teste Fries.

Clathrus recutitus L. Sp. Pl., ed. 2, 1649 (1763), doubtful.

Craterium difforme Fr. Stirp. Femsj., 83 (1827), undescribed.

Cribraria badia Chev. Fl. Par., 328 (1826), doubtful.

C. coccinea Pers. Syn. Fung., 190 (1801), description insufficient.

C. didermoides Schum. Enum. Pl. Saell., ii. 218 (1803), doubtful.

C. onygena Schum. l.c., ii. 219, a fungus, *Onygena faginea* Fr.

C. stellata Schum. l.c., doubtful.

Dictydium didermoides Fr. Syst. Myc., iii. 165 (1829), doubtful.

D. micropus Fr. l.c., 167, doubtful.

Diderma acuminatum Schum. l.c., 198, doubtful.

D. ramosum Pers. Syn. Fung., 166 (1801) = *Reticularia stipitata* Bull., doubtful; probably a fungus.

D. stipitatum Fr. Syst. Myc., iii. 104 (1829), doubtful.

D. trichodes Fr. l.c., 108, a fungus.

D. muscicola Link in Mag. Ges. Nat. Fr. Berl., iii. 26 (1809), doubtful.

D. nanum Fr. in Weinm., Hymeno-Gaster. 577 (1886), doubtful.

D. ossicolum Patouill. in Bull. Soc. Myc. Fr., iv. 91 (1888), doubtful.

D. parietinum Schrad. Nov. Pl. Gen., 24 (1797), a fungus, *Anixia truncigena* Fr.

D. plicatum Corda Icon. Fung., iii. 17 (1839), doubtful.

D. ramosum Duby Bot. Gall., ed. 2. ii. 859 (1830) = *Reticularia stipitata* Bull., q.v.

D. Sowerbeii Berk. in Sm. Engl. Flora, v. pt. 2. 313 (1836), doubtful.

D. trichodes Link l.c., a fungus, *Peziza Lonicerae* Alb. & Schw., teste Rostafinski.

D. Weinmanni Fr. Syst. Myc., iii. 121 (1829), doubtful.

Leangium physaroides Link l.c., doubtful.

Licea badia Fr. Syst. Myc., iii. 198 (1829), a fungus, perhaps one of the *Perisporiaceae*, teste Rostafinski.

L. BERTEROANA Mont. Fl. Chil., viii. 20 (1852), probably a perisporiaceous fungus, teste Rostafinski.
L. BICOLOR Pers. Syn. Fung., 195 (1801), a fungus, *Anixia truncigena* Fr.
L. LINDHEIMERI Morg. in Journ. Cinc. Soc. Nat. Hist., xv. 131 (1893) = an ascomycete, probably a species of *Emericella*.
L. MACROSPORA Schum. Enum. Pl. Saell., ii. 219 (1803), a fungus, *Polyangium umbrinum* Fr., teste Fries.
L. PANNORUM Wallr. Fl. Crypt. Germ., ii. 344 (1833) = *Anixia truncigena* Fr.
L. EPIPHYLLA Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 259, description inadequate.
L. SPUMARIOIDEA Cooke & Massee in Grev., xvi. 74 (1888), is a fungus, *Sepedonium chrysospermum* Link.
L. STROBILINA Alb. & Schwein. Consp. Fung., 109 (1805), a fungus, *Aecidium strobilinum* Reess.
L. SUBEREA Fr. Syst. Myc., iii. 198 (1829), a fungus, *Aecidium* sp.
L. SULPHUREA Wallr. Fl. Crypt. Germ., ii. 344 (1833), a fungus, *Anixia truncigena* Fr.
LYCOGALA ATRA Pers. Syn. Fung., 159 (1801), a fungus, *Apiosporium* sp., teste Fuckel.
L. GLOBOSA Schrank Baier. Fl., ii. 638 (1789), a fungus.
L. MINUTUM Sacc. & Paol. in Atti R. Inst. Ven. Sc. &c., Ser. vi. 391 (1888), doubtful.
L. NIVEUM Hoffm. Veg. Crypt., ii. 9, t. 2, f. 4 (1790), is apparently *Lamproderma* sp., immature.
L. OCHRACEUM Mass. Mon., 125 (1892), is a fungus.
L. PARIETINUM Fr. l.c., 83 = *Didymium parietinum* Schrad., q.v.
L. RUFO-CINNAMOMEUM Mass. l.c., is a fungus.
L. TERRESTRE Fr. Symb. Gast., 10 (1817), doubtful.
L. TORRENDII Bresadola in Torrend Flor. Myx., 88 (1909), is a fungus, *Lycoperdella Torrendii* Torr.
PERICHAENA DECIPIENS Berk. & Br. in Ann. Mag. Nat. Hist., ser. 4, xvii. 140 (1876), a fungus, *Aecidium strobilinum* Reess.
P. GREGATA Fautr. & Lamb. in Revue Mycol., xvi. 161 (1894), description insufficient.
P. PHAEOSPERMA Karst. in Revue Mycol., ix. 11 (1887), description insufficient.
P. PICEA Berk. & Br. l.c., a pyrenomycetous fungus.
PERICHAENA (?) PSEUDAECIDIUM Speg. in Ann. Soc. Cient. Argent., xxii. 187 (1886), doubtful.
P. STROBILINA Fr. Symb. Gast., ii. 11 (1817), a fungus, *Aecidium strobilinum* Reess.
PHYSARUM ANTIADES Fr. Syst. Myc., iii. 135 (1829), doubtful.
P. ATRUM Fr. l.c., 147, doubtful.
P. CHLORINUM Cooke in Grev., v. 101, t. 86, f. 10 (1877), doubtful.
P. CONNATUM Schum. l.c., 202, doubtful.
P. CRUSTIFORME Speg. in Anal. Museo Nac. Buen. Aires, vi. 100 (1899), doubtful.
P. ELEGANS Schwein. in Tr. Am. Phil. Soc., ser. 2, iv. 257 (1832), doubtful.
P. ELONGATUM Link l.c., 42, doubtful.
P. FIMETARIUM Schum. l.c., 205, doubtful.
P. FLAVOVIRENS Alb. & Schw. l.c., 97, doubtful.
P. HYPNOPHILUM Fr. l.c., 140, doubtful.
P. LUTEOVALVE Schwein. l.c., doubtful.
P. OXYACANTHE Schum. l.c., 199, doubtful.
P. PICEUM Fr. l.c., 143, doubtful.
P. POLYAEDRON Schwein. l.c., doubtful.

P. PURPURASCENS Link l.c., doubtful.
P. STIPITATUM Chev. Fl. Paris, i. 339 (1826) = *Diderma stipitatum* Fr., doubtful.
P. TUCUMANENSE Speg. in Rev. Agr. Veter. La Plata, 237 (1896), doubtful; possibly *P. melleum*.
P. VILLOSUM Schum. Enum. Pl. Saell., ii. 199 (1803), doubtful.
RETICULARIA AFFINIS Berk. & Curt. in Journ. Linn. Soc. Bot., x. 347 (1868), is a fungus.
R. APIOSPORA Berk. & Br. in Journ. Linn. Soc. Bot., xv. 82 (1876), is a fungus, *Thelephora* (?) *dendroidea*.
R. ATRORUFA Berk. & Curt. l.c., x. 347 (1868), is a fungus.
R. EPIXYLON Bull. Champ., 90, t. 472, f. 1 (1791), a fungus, *Dichosporium* sp., teste Fries.
R. FULIGINOSA Berk. & Br. l.c., xv. 82 (1876), is apparently a fungus.
R. NIGRA Bull. l.c., 88, t. 380, f. 2, probably a fungus.
R. POLYPORIFORMIS Berk. l.c., xiv. 352 (1875), is a fungus.
R. PYRRHOSPORA Berk. & Curt. l.c., x. 347 (1868), is a fungus.
R. RAMOSA Gmel. Syst. Nat., ii. 1471 (1791) = *R. stipitata* Bull., q.v.
R. SEGETUM Bull. l.c., 90, t. 472, f. 2, a fungus, *Ustilago carbo* Tul.
R. STIPITATA Bull. l.c., 89, t. 380, f. 3, probably a fungus.
ROSTAFINSKIA AUSTRALIS Spegaz. in Ann. Soc. Cient. Argent., x. 151 (1880), appears to be a fungus from the description.
SPHAEROCARPUS ANTIADES Bull. l.c., 127, t. 368, f. 2, doubtful.
S. FICOIDES Bull. l.c., 129, t. 417, f. 2, doubtful.
SPUMARIA FLAVA Schum. l.c., 195, doubtful.
S. MICHENERI Berk. in Grev., ii. 52 (1873), doubtful.
S. PALLIDA Schum. l.c., doubtful.
STEMONITIS ALBA Schrank Baier. Fl., ii. 635 (1789), doubtful.
S. CARNEA Schrank l.c., probably a mould.
S. COCCINEA Gmel. l.c., 1468, doubtful.
S. FILICINA Schrank l.c., 634, doubtful.
S. FLAVESCENS Schrank l.c., 19 (1790), doubtful.
S. FLUMINENSIS Spegaz. l.c., xii. 255 (1881), doubtful, evidently an ill-developed specimen.
S. FULVA Gmel. l.c., 1468, doubtful.
S. FURFURACEA Gmel. l.c., doubtful.
S. GLOBULARIS Gmel. l.c., doubtful.
S. GRANIFORMIS Gmel. l.c., doubtful.
S. LILACINA Schrank l.c., 685, doubtful.
S. NIVEA Gmel. l.c., 1467, doubtful.
S. PYRIFORMIS Roth Fl. Germ., i. 548 (1788), doubtful.
S. SULPHUREA Roth l.c., a fungus, *Eurotium herbariorum* Link.
S. VIOLACEA Roth l.c., doubtful.
TILMADOCHE CAVIPES Berk. in Grev., xi. 39 (1882), doubtful.
TRICHIA ANGULATA Schwein. l.c., 259, doubtful.
T. ANTIADES DC. Fl. Fr., ii. 252 (1805) = *Sphaerocarpus antiades* Bull., doubtful.
T. ARCYRIAEFORMIS Schum. l.c., 206, doubtful.
T. CRASSA Schum. l.c., 208, doubtful.
T. DIFFORME Schwein. l.c., 259, doubtful.
T. FURFURACEA Wither. Brit. Pl. 2, iii. 392 (1793), doubtful.
T. LENTICULARIS Hoffm. l.c., 16, t. 4, f. 3, doubtful.
T. LICHENOIDES Sibth. Fl. Oxon., 405 (1794), possibly a lichen.
T. MINIATA Schwein. l.c., doubtful.
T. NIVEA Hoffm. l.c., 15, t. iv., f. 2, doubtful.
T. OLIVACEA Wither. l.c., iv. 392, doubtful.

T. PHYSAROIDES Schum. l.c., 210, doubtful.
T. PUNCTULATA Schwein. l.c., 259, doubtful.
T. RAMULOSA Rudolphi in Linnaea, iv. 119 (1829), probably a fungus.
T. RECUTITA Wither. l.c., doubtful.
T. RETICULATA DC. Fl. Fr., ii. 256 (1805), doubtful, possibly *Dictydium cancellatum* Macbr.
T. RUFA Hoffm. l.c., 10, t. 2, f. 5, doubtful.
T. SEMICANCELLATA DC. l.c., p. 255, doubtful.
T. SPHAEROCEPHALA Hoffm. l.c., ii. 15, t. iv., f. 2, doubtful.
T. VIOLACEA Hoffm. l.c., ii. 5, t. ii. fig. 1, doubtful.
TUBULINA BICOLOR Poiret l.c., a fungus, *Anixia truncigena* Fr.
T. GUARANITICA Mass. Mon., 39 (1892), is a hyphomycetous fungus.
T. SPUMARIOIDEA Cke. & Mass in Mass. l.c., 42, is the fungus *Sepedonium chrysospermum* Link.

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GLOSSARY

Aethalium : A compound fructification formed by the union of many sporangia ; the walls of the inner sporangia are more or less imperfectly developed.

Amoeba : Microscopic animalcule perpetually changing shape.

Amoeboid movement : Changing shape like an amoeba.

Capillitium : A system of simple or branched, solid or tubular threads, developed within the sporangium, and usually assisting in the dispersion of spores.

Cartilaginous : A term applied to a stout, uniformly thickened membrane.

Columella : A supporting structure arising from the base of the sporangium and giving attachment to the capillitium ; it may be solid or hollow, and either convex, conical, clavate, or cylindrical ; in stalked sporangia it is directly continuous with the stalk.

Cortex : An outer covering investing the aethalium.

Cytoplasm : The finely granular and hyaline portion of protoplasm.

Effused : Flattened and irregularly extended.

Elaters : Free tubular capillitium-threads marked with spiral bands, characteristic of the genera *Trichia* and *Oligonema*.

Epispore : The outer layer of the spore-wall.

Fusiform : Spindle-shaped.

Flagellum : The whip-like organ of motion of a swarm-cell.

Gregarious : Arranged in loose clusters.

Hyaline : Glassy clear.

Hyphae : Threadlike organs of which the vegetative parts of fungi are composed.

Hyaloplasm : That part of the cytoplasm which is free from granules.

Hypothallus : A membrane or system of strands connecting the bases of the sporangia or of their stalks.

Karyokinesis : Indirect division of a nucleus by a complicated process resulting in the bipartition of deeply staining nuclear bodies, the chromosomes.

Laciniate : Jagged or torn.

Lime-knots : Expansions in the threads of the capillitium containing granules of calcium-carbonate.

Macrocyst : The resting condition of a very young plasmodium, consisting of a mass of cytoplasm with nuclei, enclosed in a double wall.

Microcyst : The resting condition of a swarm-cell, consisting of a small spherical mass of cytoplasm and a nucleus, enclosed by a hyaline wall.

Mitosis : Indirect division of nucleus, see Karyokinesis.

Muricate : Rough with hooked spines.

Nodes : In the genus *Cribraria*, the upper half at least of the sporangium wall persists as a network of slender threads, usually conspicuously enlarged or thickened at the points of junction or *nodes*.

Plasmodiocarp : Sessile sporangia having a vein-like or irregular outline.

Plasmodic Granules : Minute, strongly refracting, usually coloured granules, conspicuous in the walls of sporangia of the genera *Lindbladia*, *Cribraria*, and *Dictydium* ; they dissolve in acid, and are well preserved in Canada balsam.

Plasmodium : A mass of naked protoplasm formed by the union of swarm-cells, and exhibiting a rhythmic circulation.

Pseudo-capillitium : The name applied to the imperfectly developed walls of the component sporangia of an aethalium, that may resemble true capillitium.

Pseudo-columella : In the *Physaraceae*, a mass of lime-knots confluent in the centre of the sporangium, resembling a columella but remaining free from the stalk.

Pseudopodium : A process, constantly changing form, thrown out by an *amoeba*.

Pulvinate : Cushion-like.

Pyriform : Pear-shaped.

Sclerotium : The resting condition of the plasmodium ; it is formed of numerous, closely compacted cysts, the 'sclerotium cysts', each consisting of a mass of cytoplasm with ten to twenty nuclei, and enclosed by a wall of cellulose ; the dry horny sclerotium may retain its vitality for several years.

Sporangium : A receptacle containing spores.

Sporophore : A structure bearing spores on its surface (compare *Ceratiomyxa*).

Subulate : Awl-shaped.

Swarm-cell : The protoplasmic body that emerges from the spore on germination ; it contains a nucleus and contracting vacuole ; at first it is amoeboid, later it becomes pear-shaped with the narrow end prolonged into a flagellum with which it swims in the water.

Terete : Having a circular transverse section.

Turbinate : Top-shaped.

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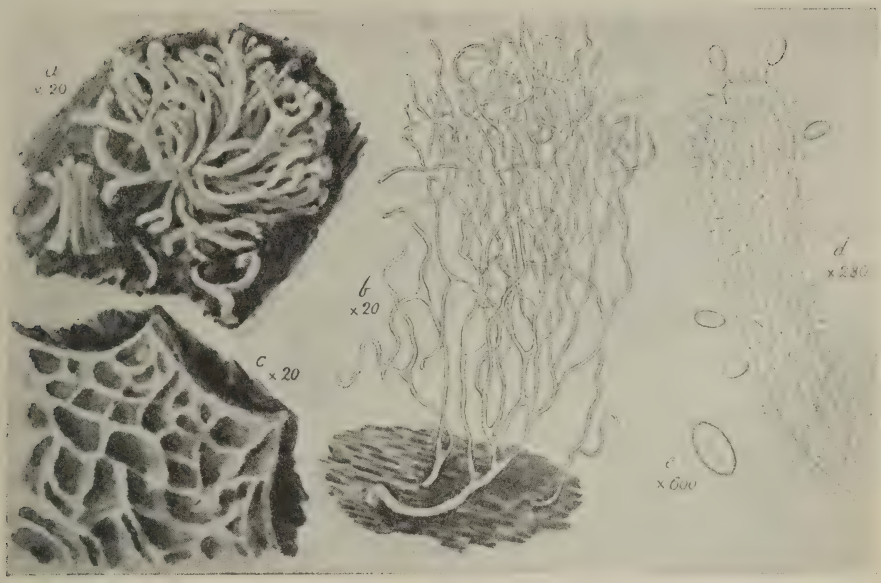
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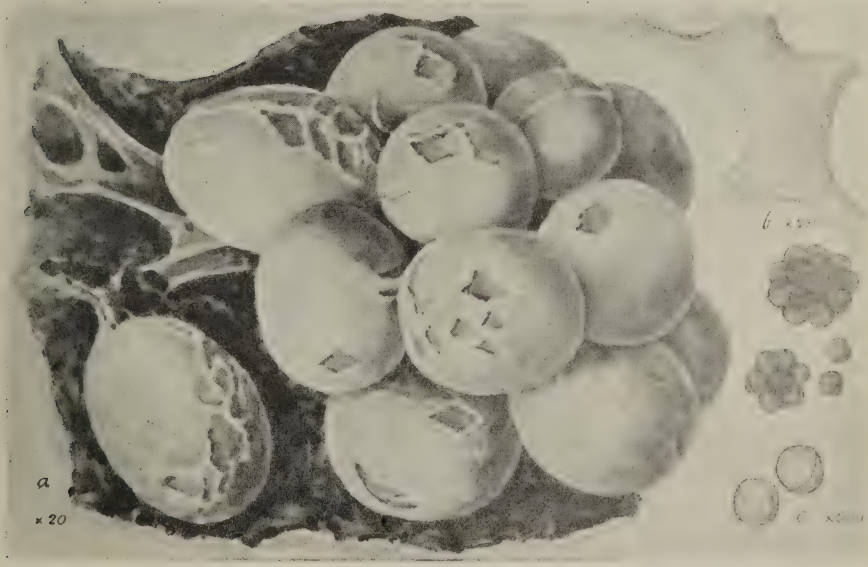
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1. CERATIOMYXA FRUTICULOSA Macbride



2. BADHAMIA POPULINA Lister

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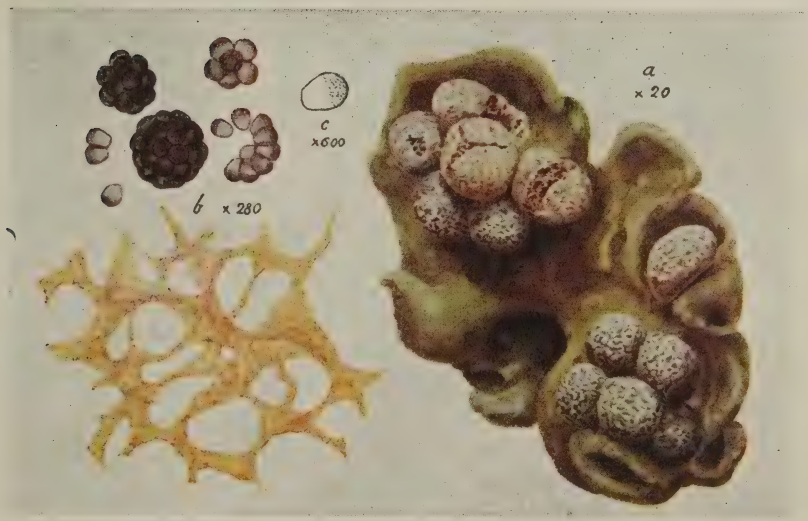
3. *a—c*, BADHAMIA CAPSULIFERA Berk.
d, *e*, B. PAPAVERACEA Berk. & Rav.



4. BADHAMIA UTRICULARIS Berk.



5. BADHAMIA NITENS Berk.



6. BADHAMIA VERSICOLOR Lister

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7. BADHAMIA DECIPIENS Berk.

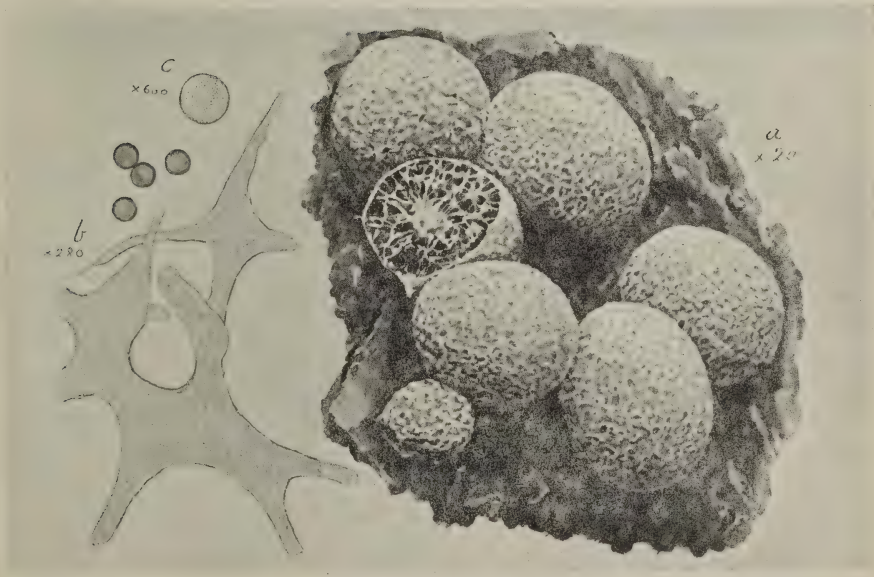


8. *a*—*c*, BADHAMIA MACROCARPA Rost
d—*f*, B. AFFINIS Rost. var. ORBICULATA G. Lister.

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9. BADHAMIA MAGNA Peck



10. BADHAMIA PANICEA Rost.

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11. BADHAMIA FOLIICOLA Lister

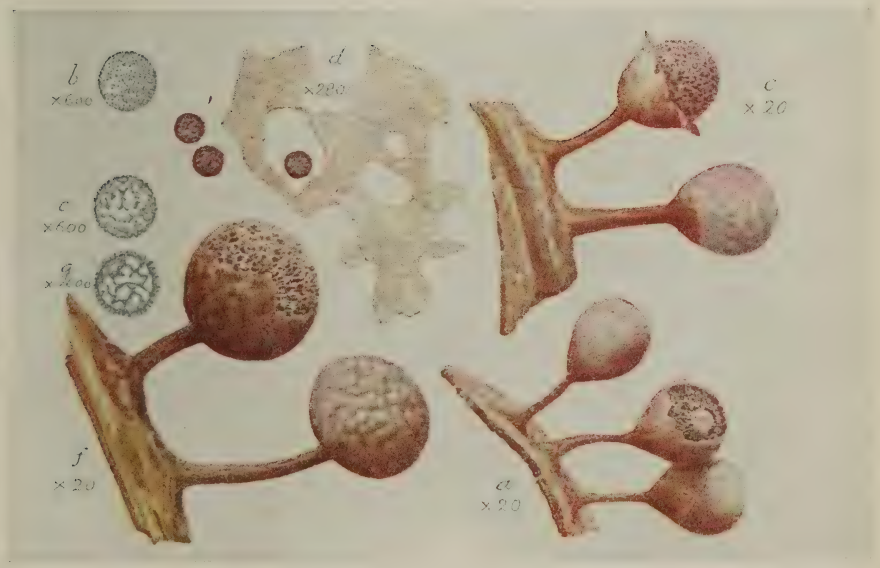


12. BADHAMIA OVISPORA Racib.

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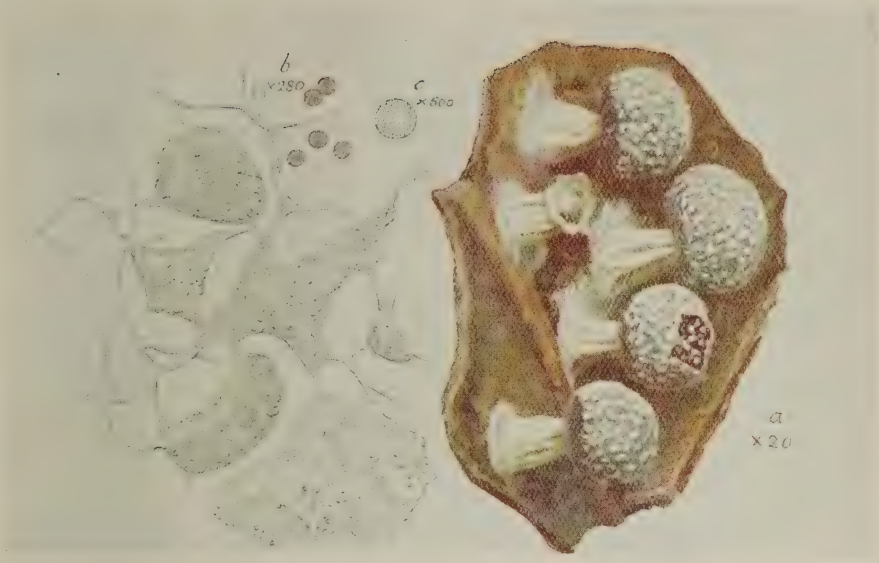


13. BADHAMIA LILACINA Rost.



14. BADHAMIA RUBIGINOSA Rost.

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15. PHYSARUM LEUCOPUS Link

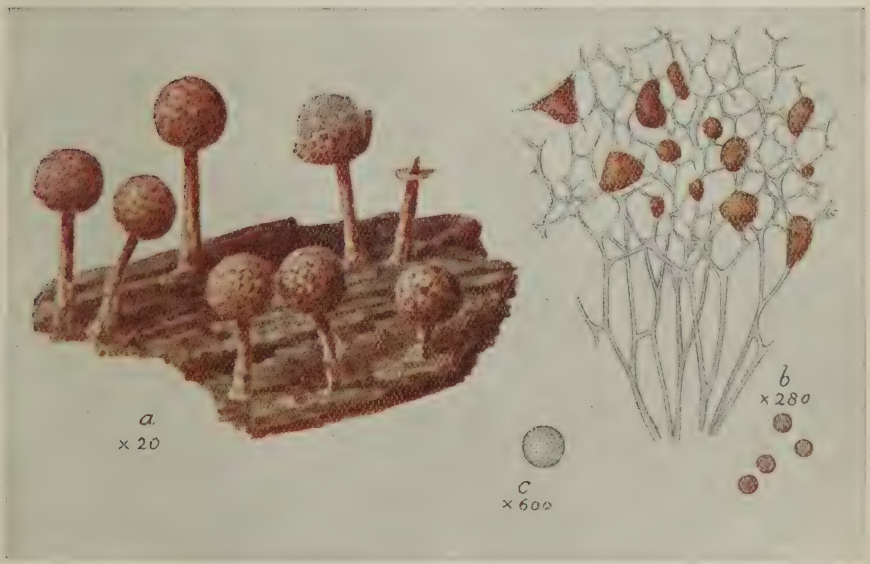


16. PHYSARUM GLOBULIFERUM Pers.

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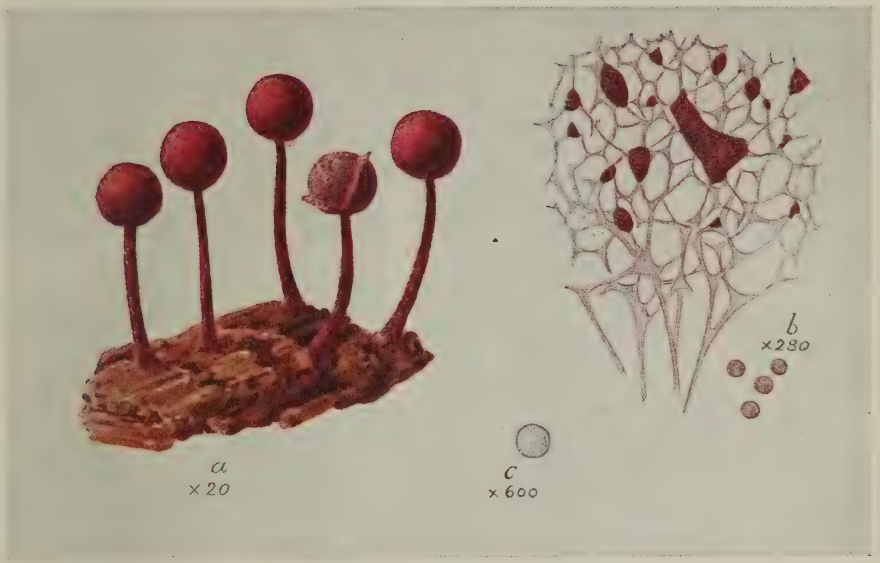


17. PHYSARUM PULCHERRIPES Peck



18. PHYSARUM MURINUM Lister

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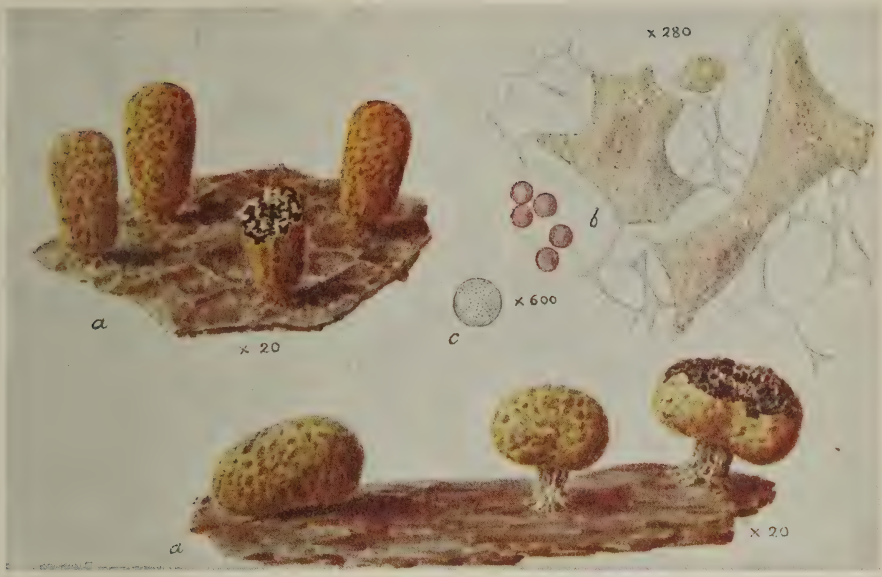


19. PHYSARUM PULCHERRIMUM Berk. & Rav.



20. PHYSARUM CITRINUM Schum.

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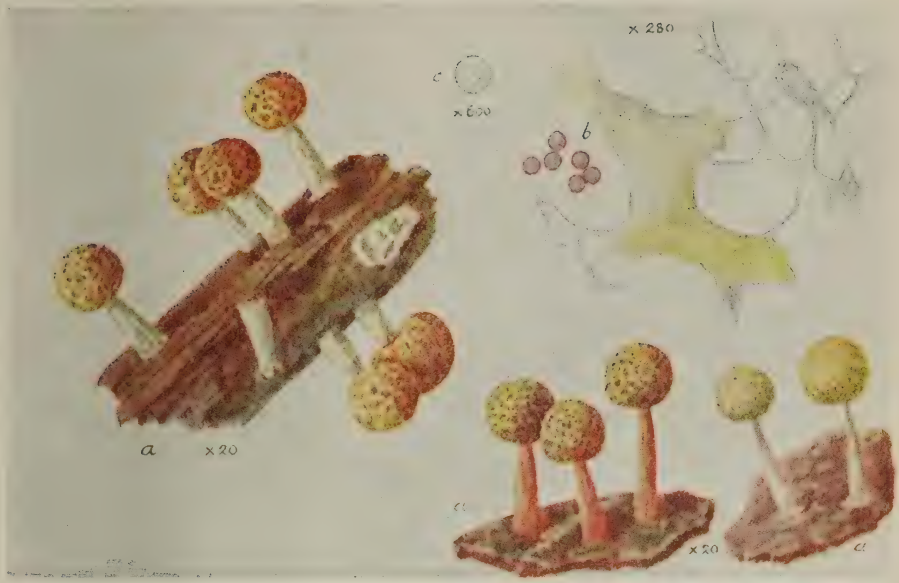


21. PHYSARUM SULPHUREUM Alb. & Schw. var. VARIABILE Lister



22. PHYSARUM SESSILE Brandza

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23. PHYSARUM MELLEUM Massee



24. PHYSARUM LUTEOALBUM Lister

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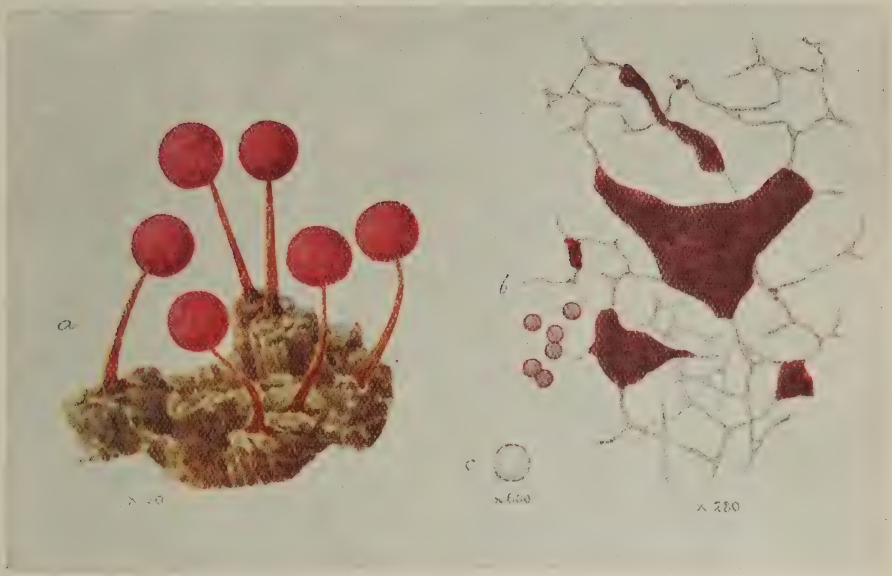


25. PHYSARUM TENERUM Rex

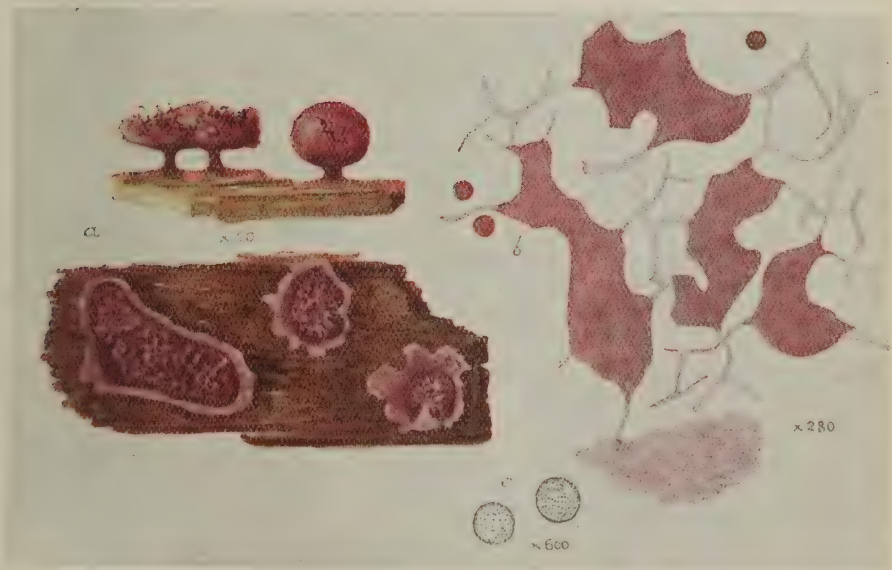


26. PHYSARUM COLUMBINUM Sturgis

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27. PHYSARUM ROSEUM Berk. & Br.



28. PHYSARUM NEWTONI Macbride

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29. PHYSARUM PSITTACINUM Ditmar

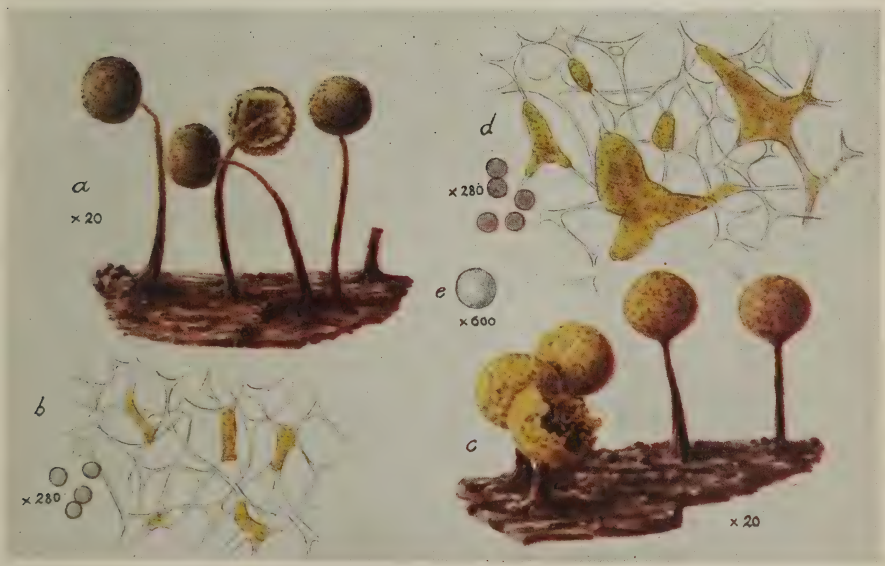


30. PHYSARUM DICTYOSPERMUM Lister

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31. PHYSARUM VIRIDE Pers.



32. *a*, *b*, PHYSARUM FLAVICOMUM Berk

c—*e*, P. MAYDIS Torrend

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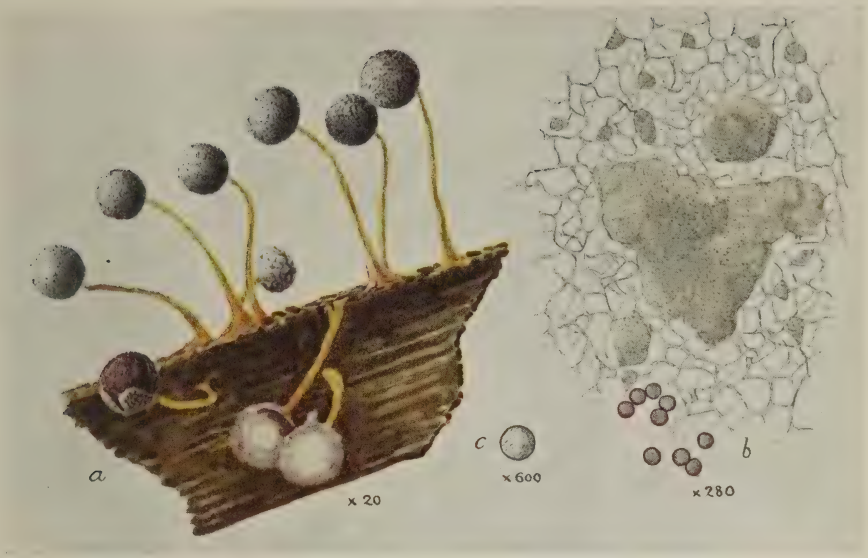


33. PHYSARUM AURISCALPIUM Cooke

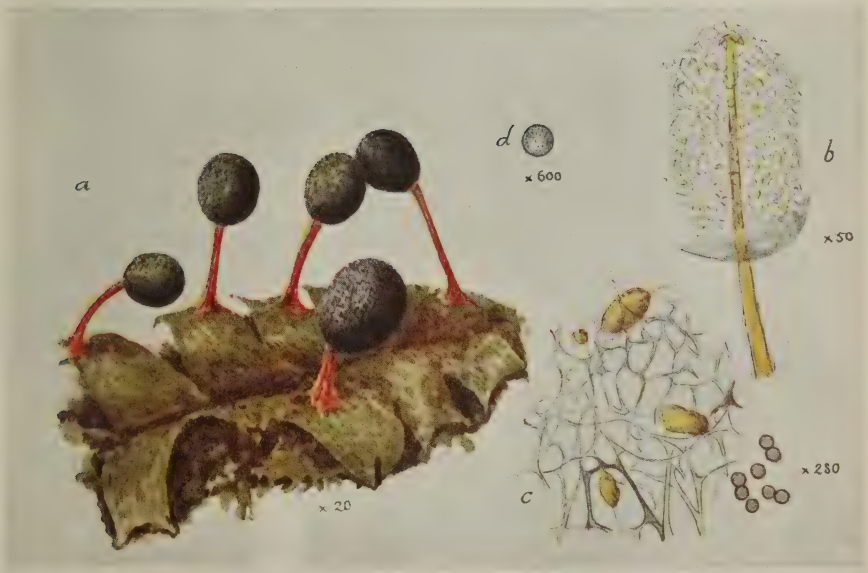


34. PHYSARUM POLYCEPHALUM Schwein.

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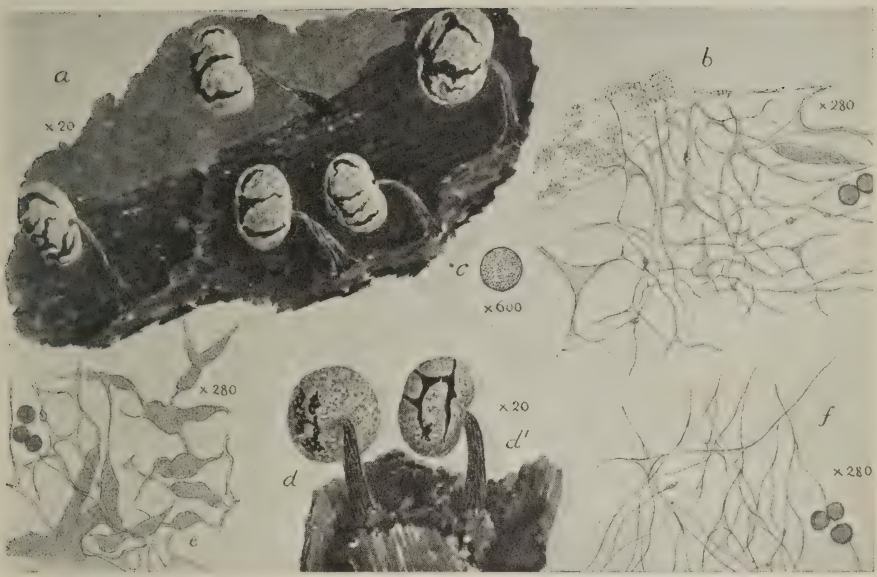


35. PHYSARUM NUCLEATUM Rex

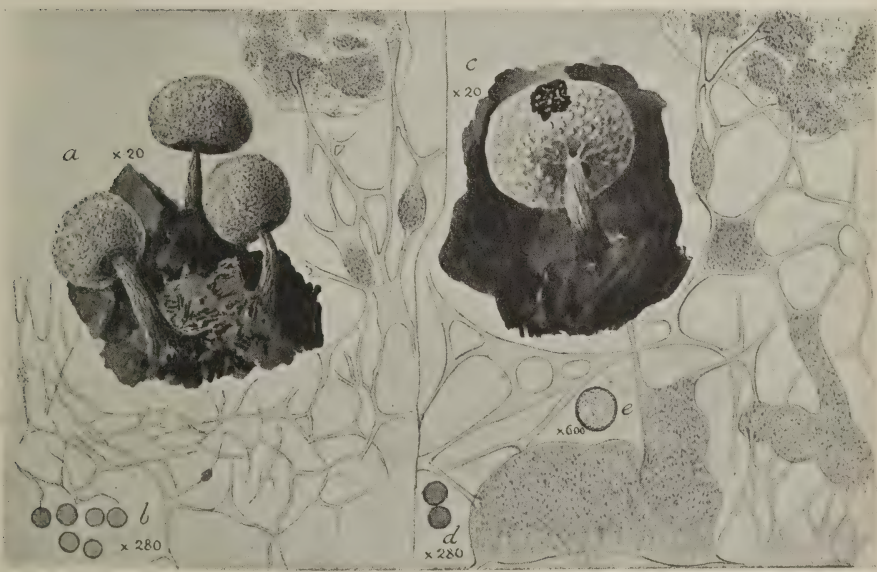


36. PHYSARUM PENETRALE Rex

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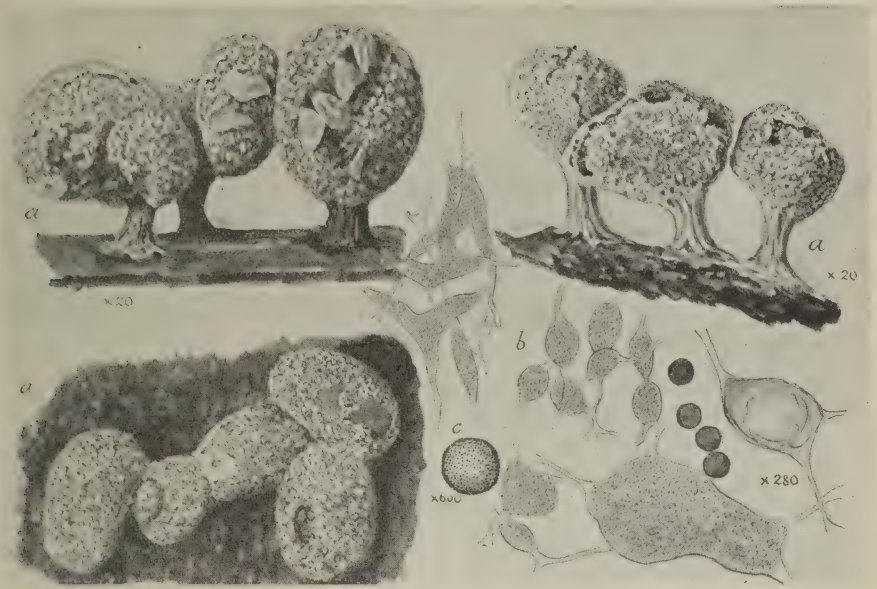


37. PHYSARUM NUTANS Pers.

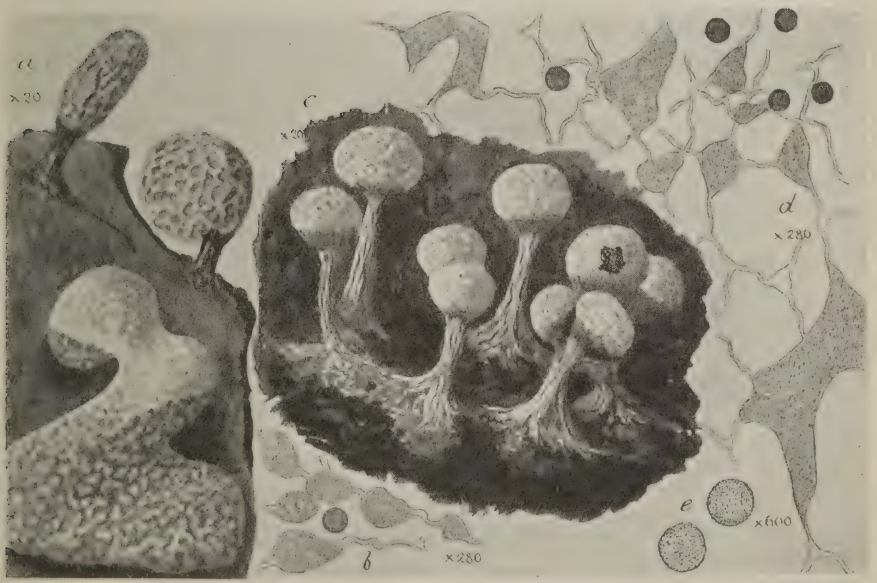


38. PHYSARUM NUTANS subsp. LEUCOPHAEUM Lister

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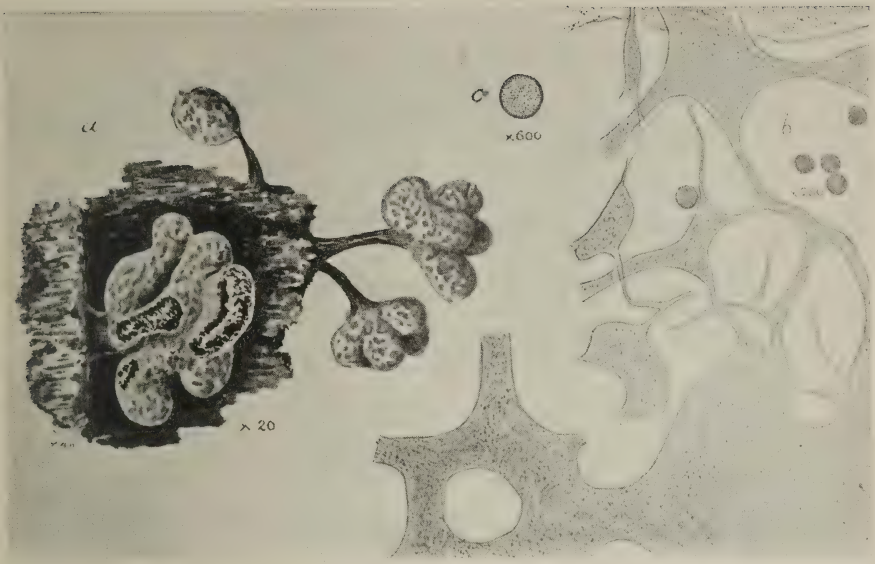


39. PHYSARUM COMPRESSUM Alb.& Schw.



40. *a*, *b*, PHYSARUM COMPRESSUM Alb. & Schw.: *c*—*e*, P. CONNATUM Lister

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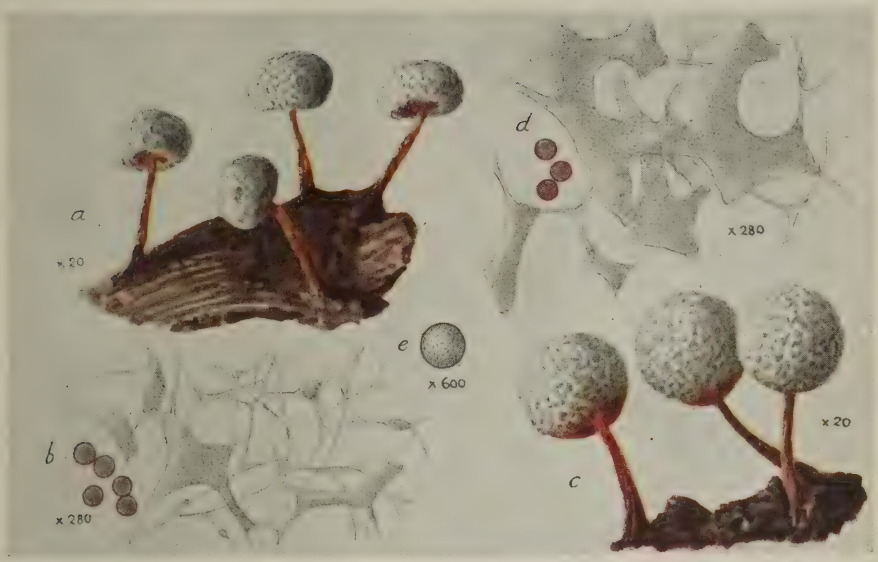


41. PHYSARUM RENIFORME Lister



42. PHYSARUM STRAMINIPES Lister

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43. PHYSARUM PUSILLUM Lister



44. PHYSARUM MUTABILE Lister

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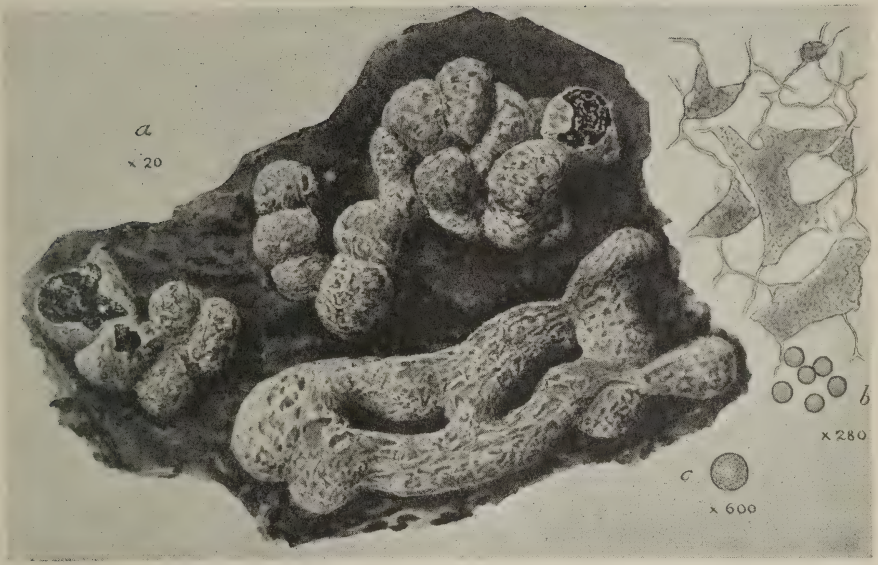


45. PHYSARUM DIDERMOIDES Rost.

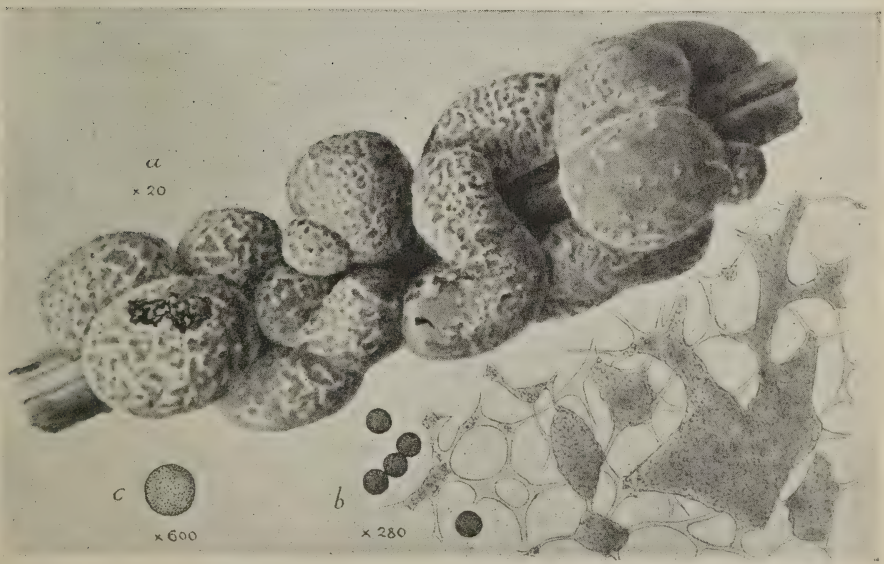


46. PHYSARUM DIDERMOIDES Rost. VAR. LIVIDUM Lister

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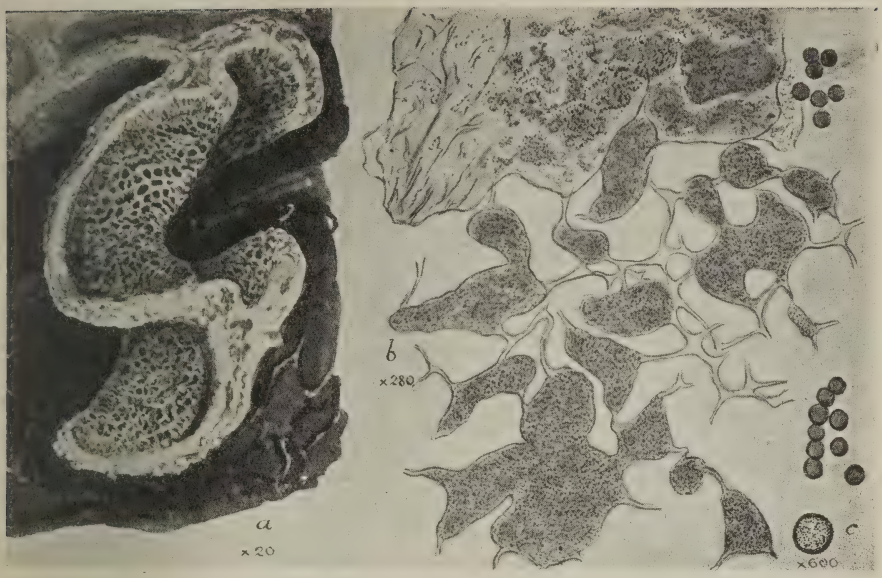


47. PHYSARUM CINEREUM Pers.



48. PHYSARUM VERNUM Somm.

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49. PHYSARUM SINUOSUM Weinm.



50. PHYSARUM BOGORIENSE Racib.

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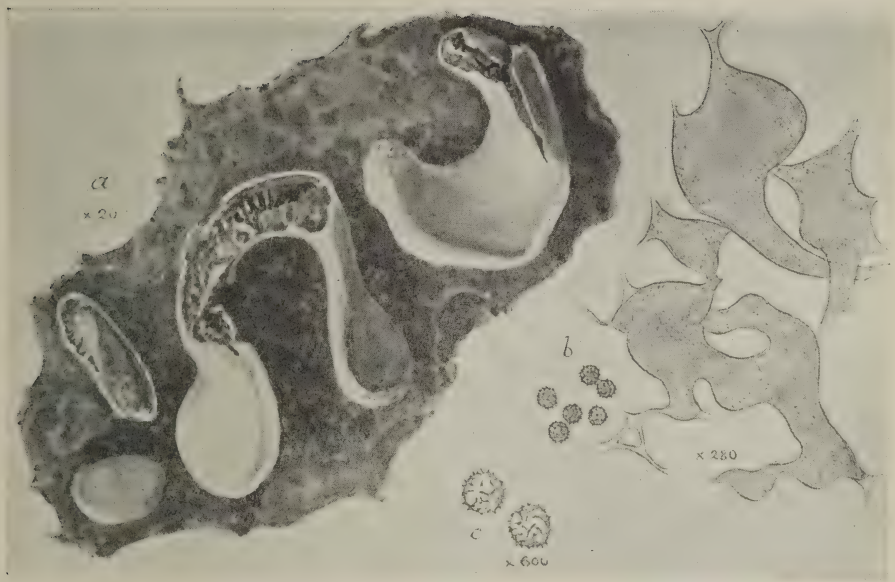


51. PHYSARUM BITECTUM Lister

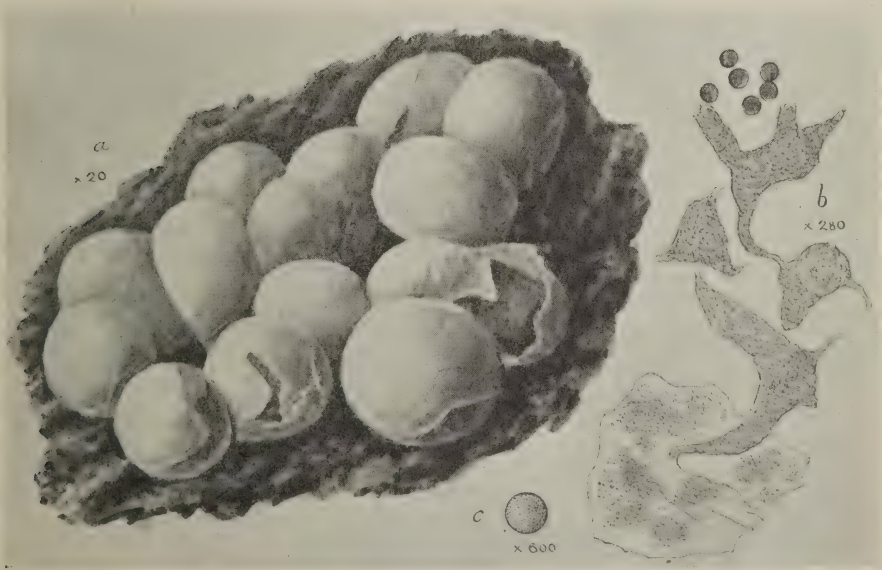


52. PHYSARUM GYROSUM Rost.

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53. PHYSARUM ECHINOSPORUM Lister



54. PHYSARUM TESTACEUM Sturgis

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55. PHYSARUM CONTEXTUM Pers.



56. PHYSARUM CONGLOMERATUM Rost.

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57. PHYSARUM SERPULA Morgan



58. PHYSARUM ÆNEUM R. E. Fries

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59. PHYSARUM RUBIGINOSUM Fries



60. PHYSARUM LATERITIUM Lister

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61. *a—c*, PHYSARUM VIRESCENS Ditmar
d, P. LATERITIUM Morgan

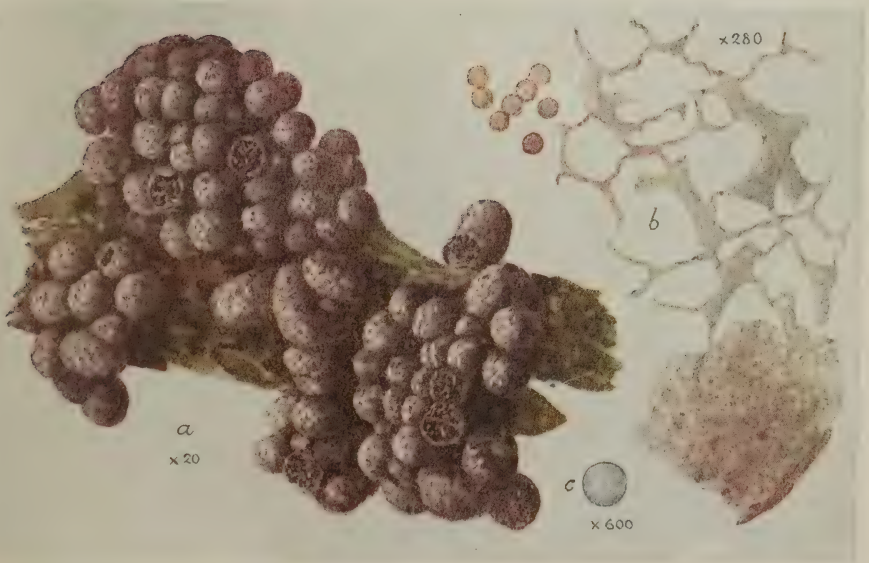


62. *a—c*, PHYSARUM VIRESCENS Ditmar VAR. NITENS Lister
d—f, P. ALPINUM Lister

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63. PHYSARUM FAMINTZINI Rost.



64. PHYSARUM CONFERTUM Macbride

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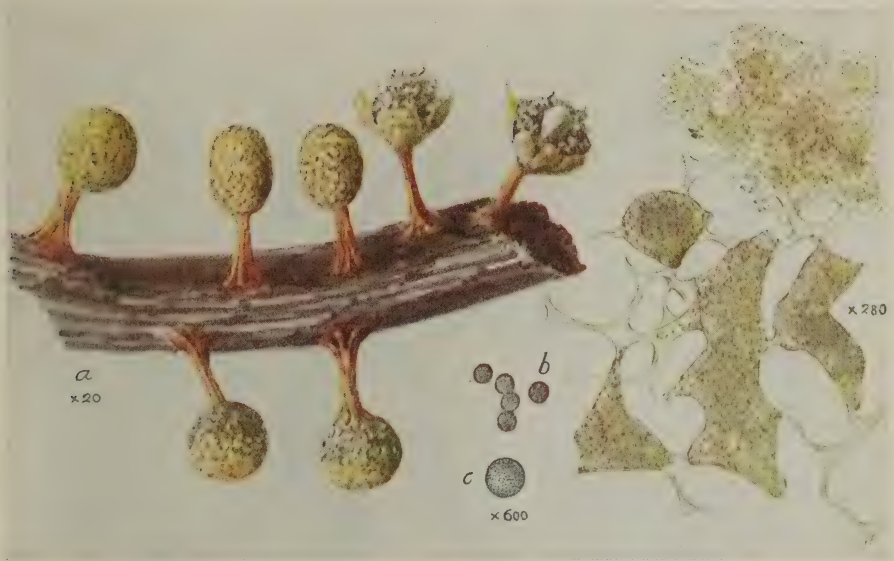


65. PHYSARUM SULPHUREUM Alb. & Schwein.



66. PHYSARUM FULVUM Lister

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67. CRATERIUM AUREUM Rost.

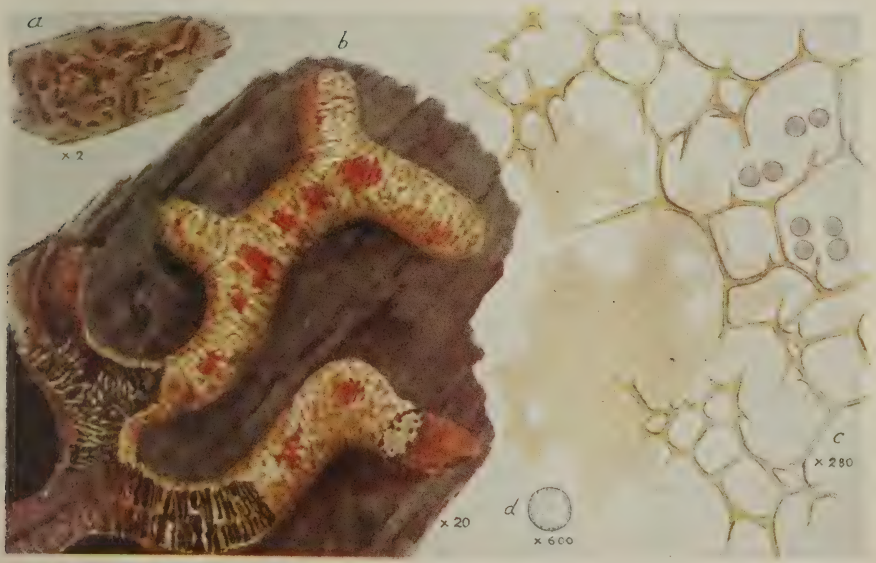


68. PHYSARUM CITRINELLUM Peck

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69. PHYSARUM BRUNNEOLUM Massee



70. CIENKOWSKIA RETICULATA Rost.

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71. PHYSARELLA OBLONGA Morgan



72. TRICHAMPHORA PEZIZOIDEA Jungh.

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73. ERIONEMA AUREUM Penzig

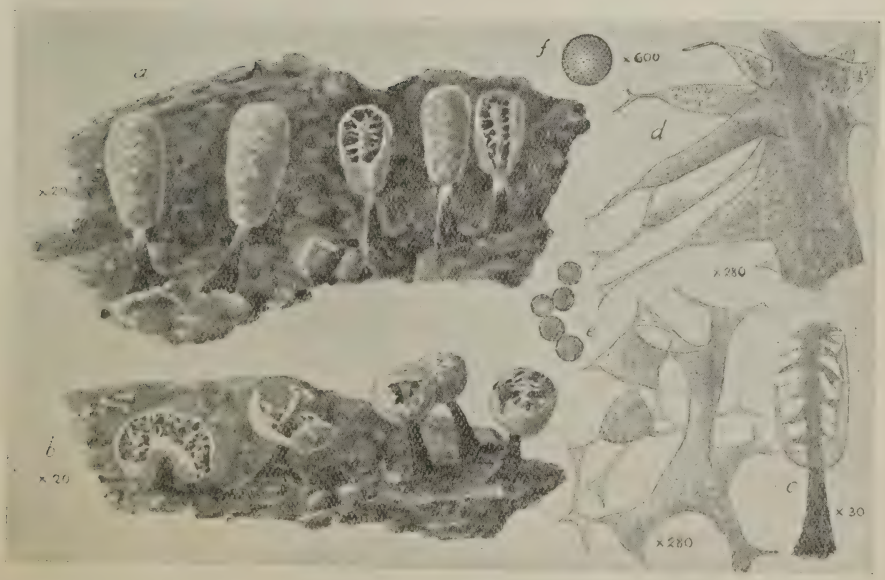


74. FULIGO SEPTICA Gmelin

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75. FULIGO CINEREA Morgan



76. PHYSARUM CRATERIFORME Petch

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77. FULIGO MUSCORUM Alb. & Schwein.



78. CRATERIUM MINUTUM Fries

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79. CRATERIUM CONCINNUM Rex



80. CRATERIUM PARAGUAYENSE Lister

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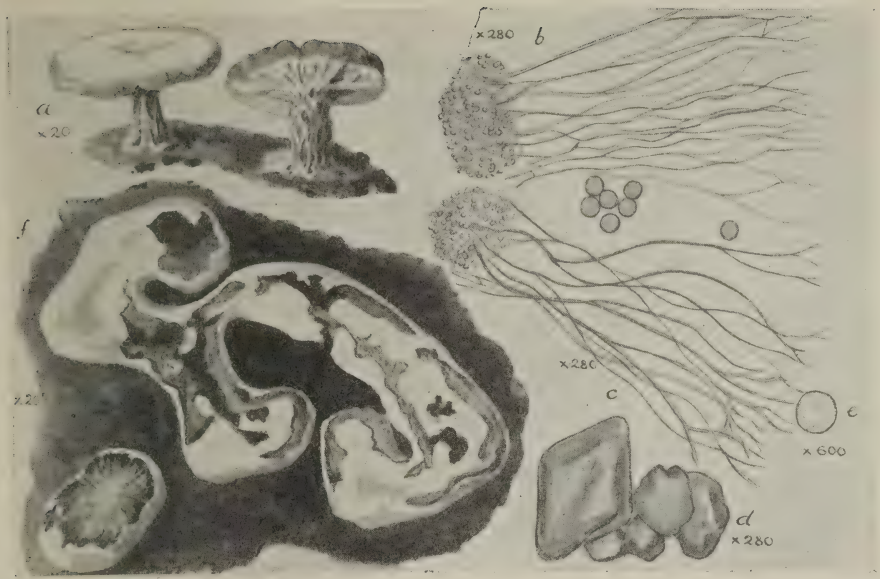


81. CRATERIUM LEUCOCEPHALUM Ditmar

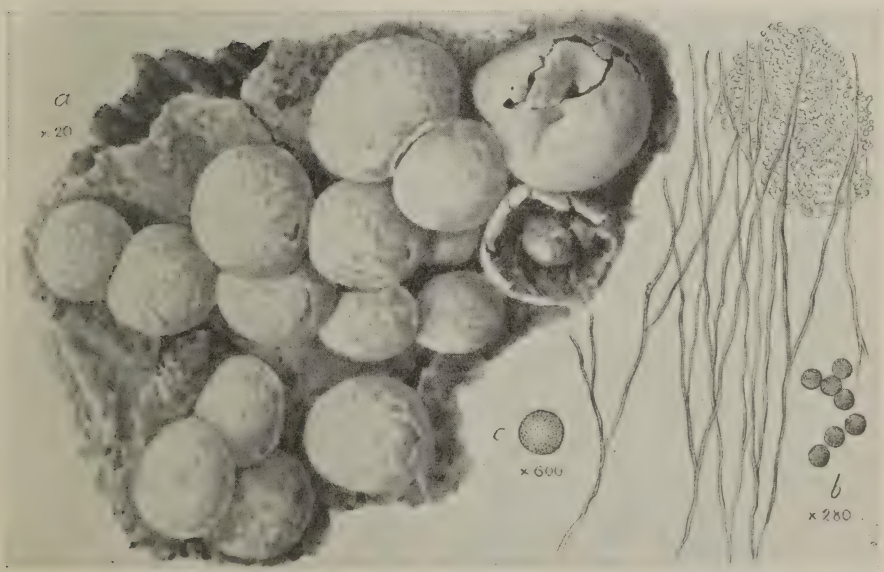


82. LEOCARPUS FRAGILIS Rost.

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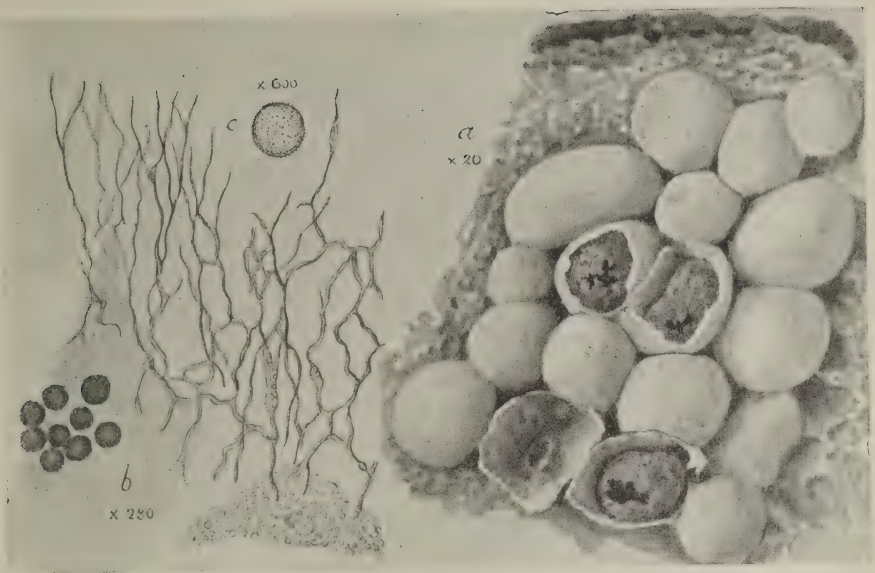


83. *a—e*, DIDERMA HEMISPHERICUM Hornem.
f, D. EFFUSUM Morgan



84. DIDERMA SPUMARIOIDES Fries

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85. DIDERMA GLOBOSUM Pers.



86. DIDERMA RUGOSUM Macbride

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87. *a*—*c*, DIDERMA TESTACEUM Pers.
d—*f*, D. SUBDICTYOSPERMUM Lister



88. DIDERMA SIMPLEX Lister

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89. *a*—*c*, DIDERMA NIVEUM Macbride
d, D. DEPLANATUM Fries



90. DIDERMA LYALLII Macbride

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91. DIDERMA TREVELYANI Fries



92. DIDERMA FLORIFORME Pers.

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93. DIDERMA RADIATUM Lister



94. *a*, *b*, DIDERMA RADIATUM Lister
c, *d*, D. ROANENSE Macbride

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95. DIDERMA OCHRACEUM G. F. Hoffmann



96. DIDERMA SAUTERI Macbride

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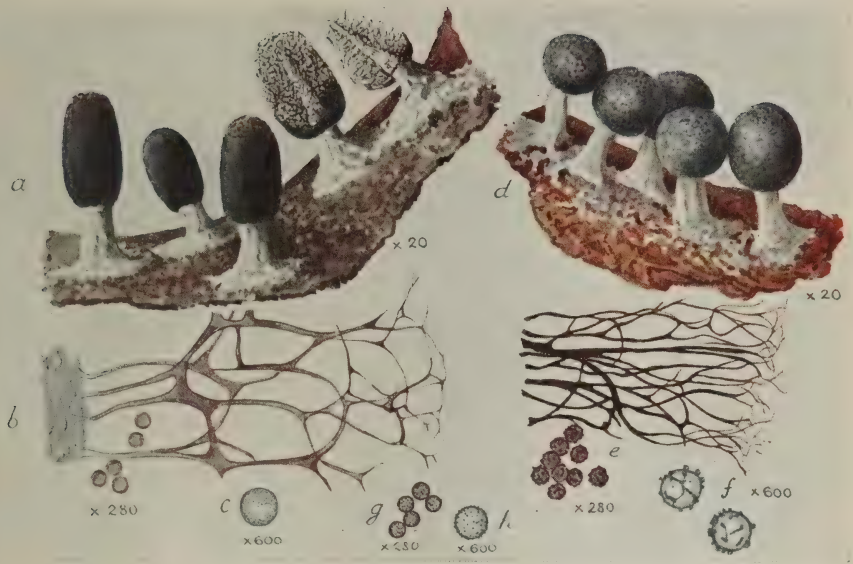


97. DIDERMA ASTEROIDES Lister



98. DIDERMA LUCIDUM Berk. & Broome

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99. *a—c*, DIACHEA LEUCOPODA Rost.
d—h, D. BULBILLOSA Lister



100. DIACHEA SUBSESSILIS Peck

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101. DIACHEA THOMASII Rex

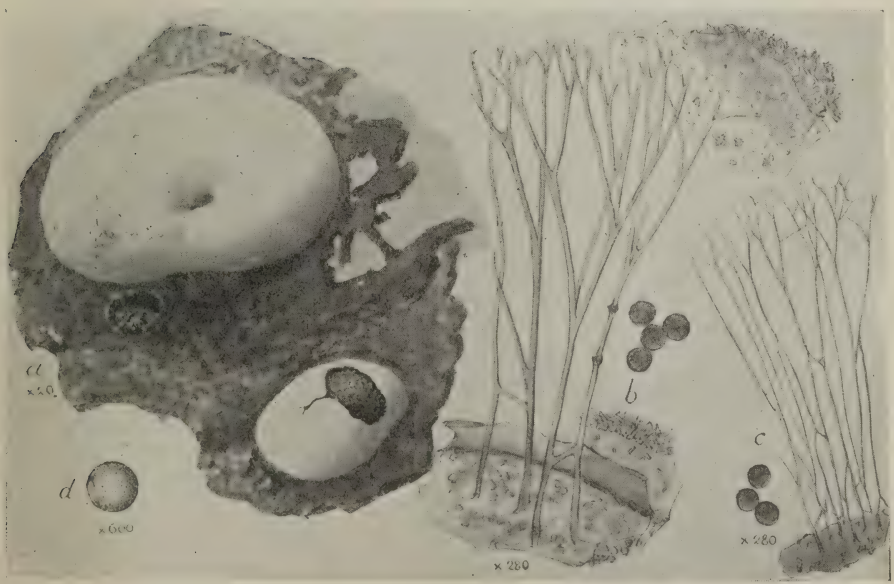


102. DIDYMIUM NIGRIPES Fries

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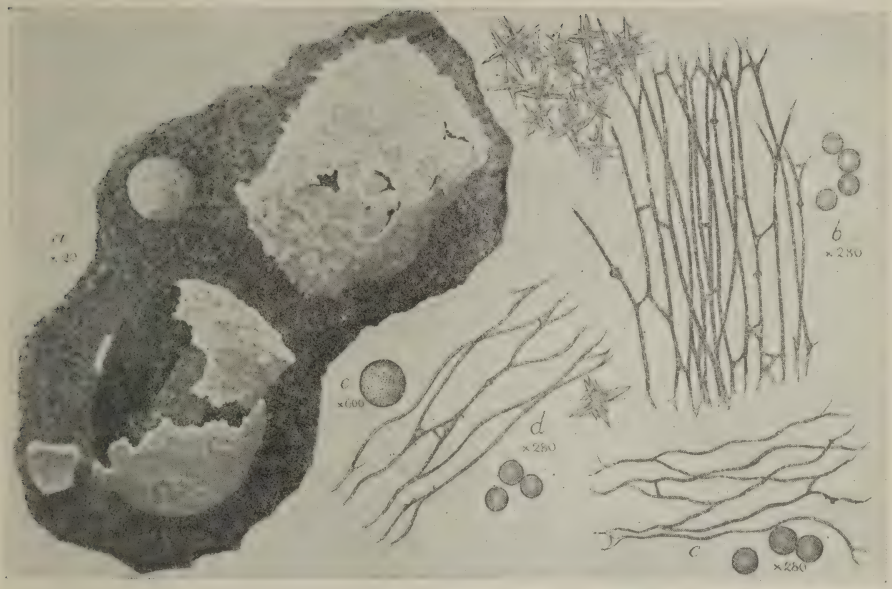


103. *a—e*, DIACHEA CYLINDRICA Bilgram
f—h, D. CÆSPITOSA Lister

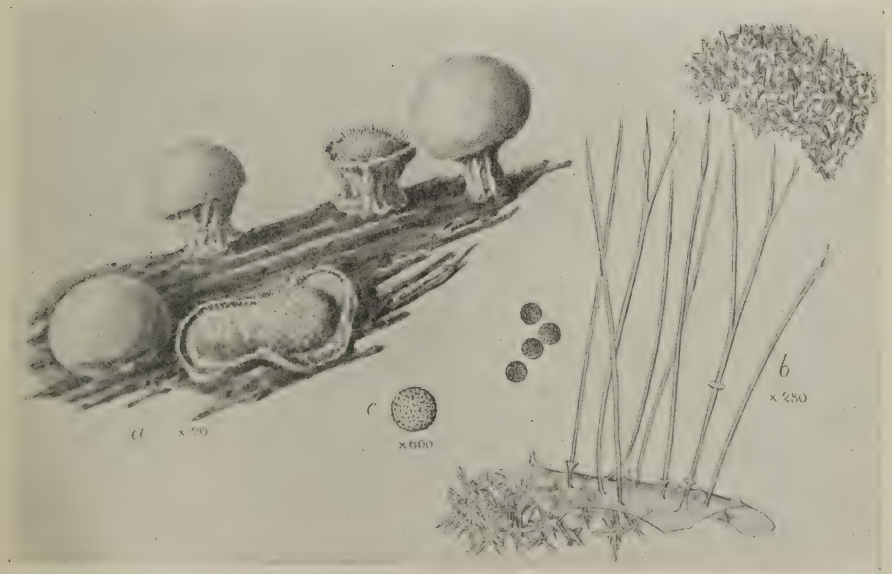


104. DIDYMIUM DIFFORME Duby

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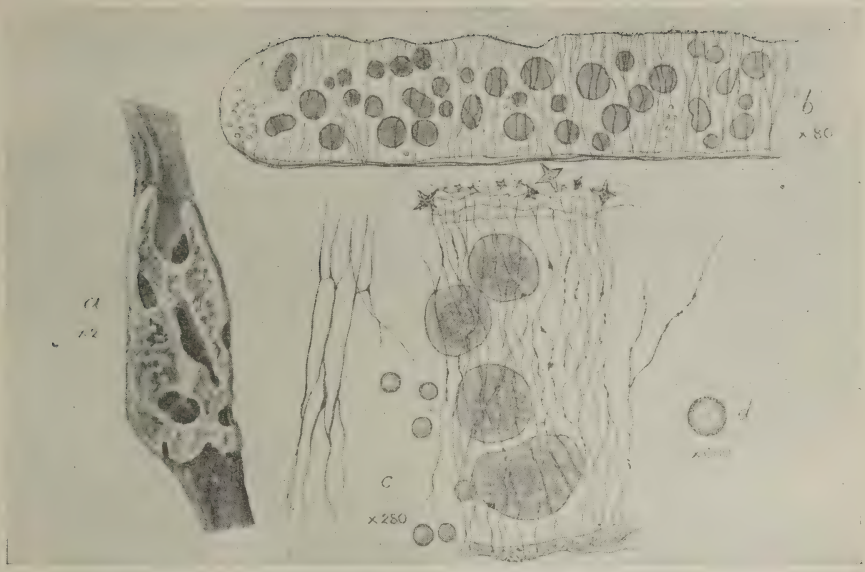


105. DIDYMIUM DUBIUM Rost.

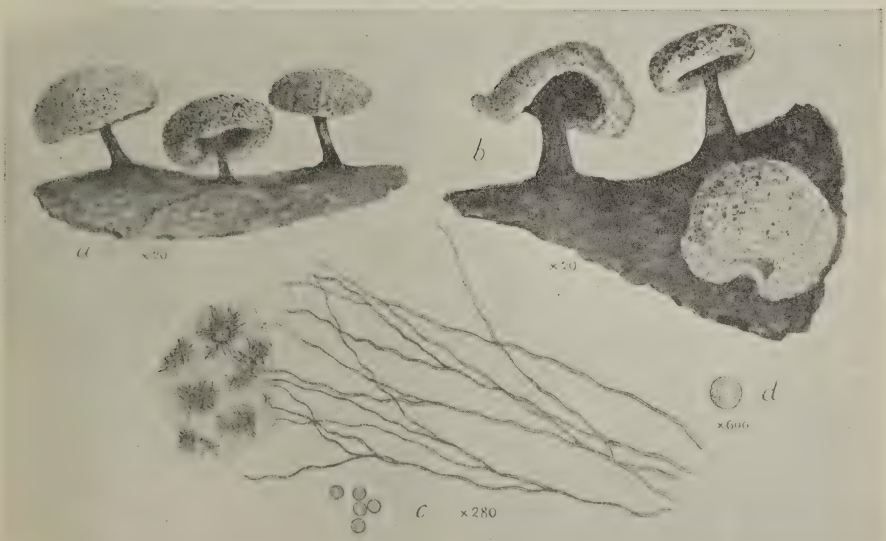


106. DIDYMIUM VACCINUM Buchet

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107. DIDYMIUM COMPLANATUM Rost.



108. DIDYMIUM CLAVUS Rabenh.

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109. DIDYMIUM SQUAMULOSUM Fries



110. *a*—*c*, DIDYMIUM ANELLUS Morgan;
d—*f*, D. INTERMEDIUM Schroeter

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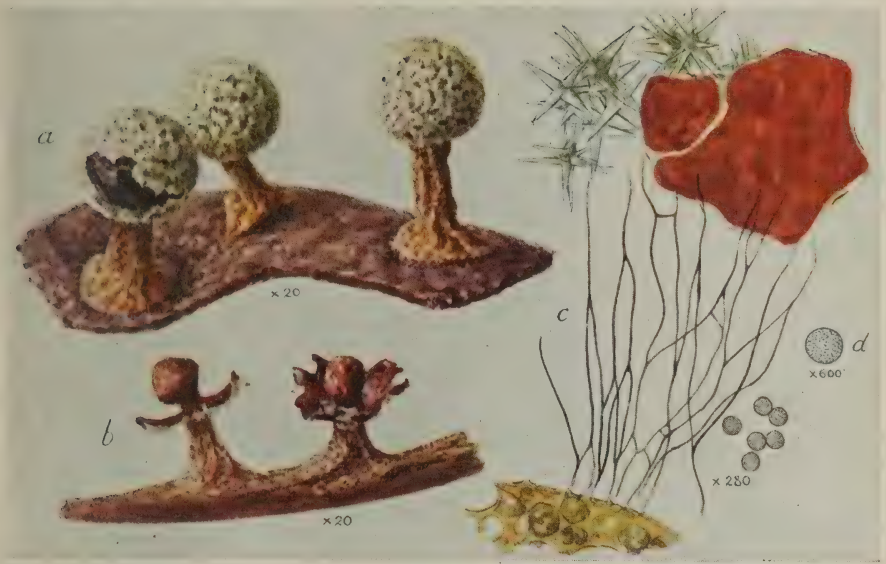


111. DIDYMIUM CRUSTACEUM Fries



112. DIDYMIUM MELANOSPERMUM Macbride

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113. DIDYMIUM LEONINUM Berk. & Br.



114. LEPIDODERMA TIGRINUM Rost.

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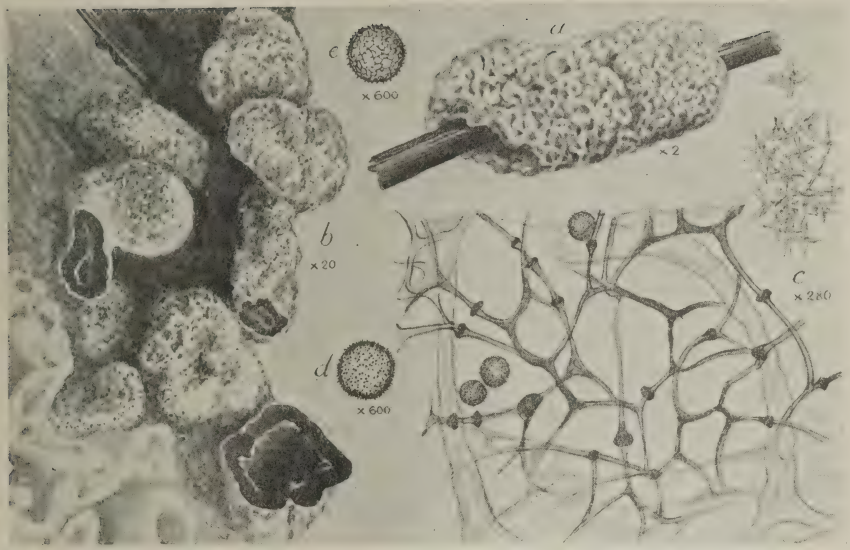


115. LEPIDODERMA CARESTIANUM Rost.

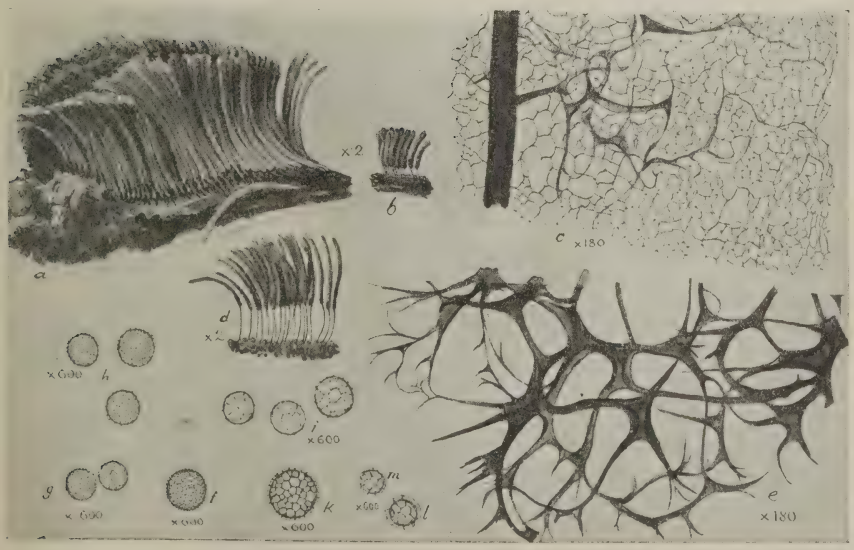


116. LEPIDODERMA CHAILLETII Rost.

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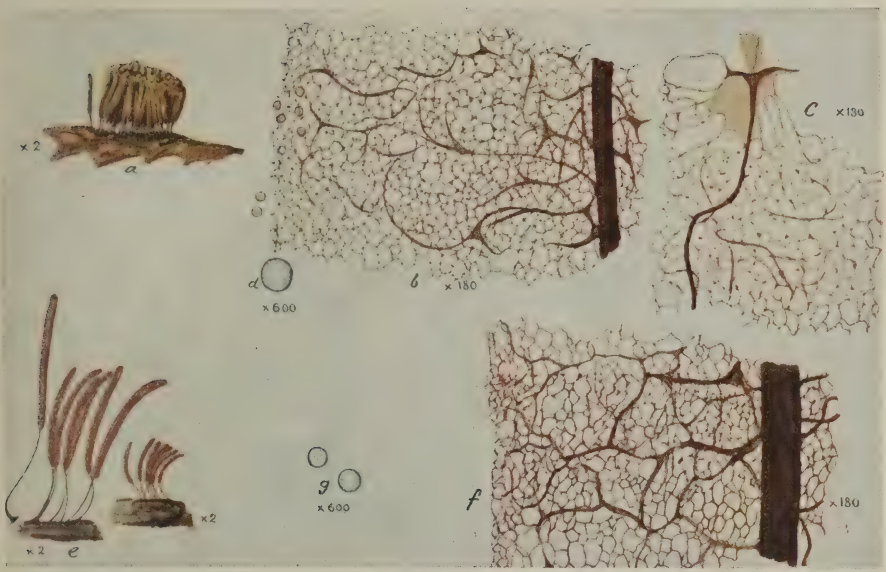


117. MUCILAGO SPONGIOSA Morgan

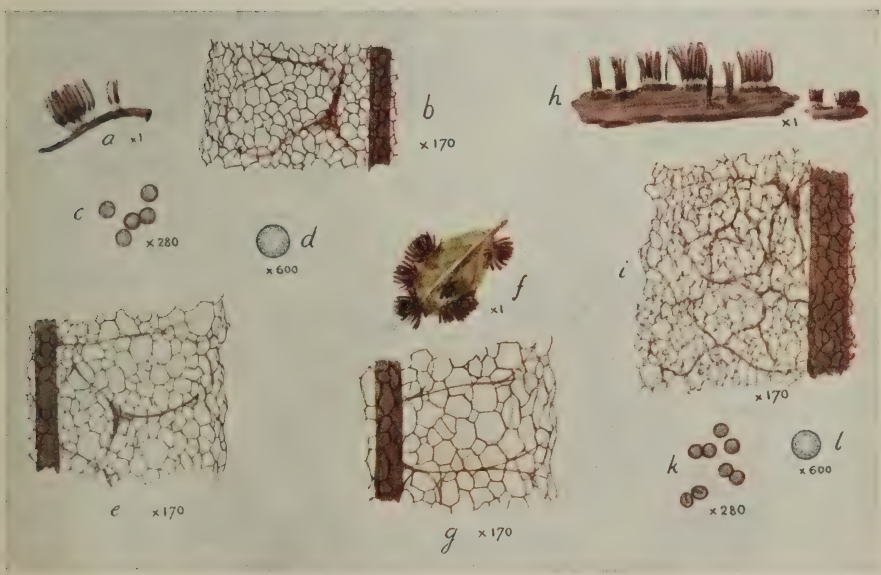


118. STEMONITIS FUSCA Roth

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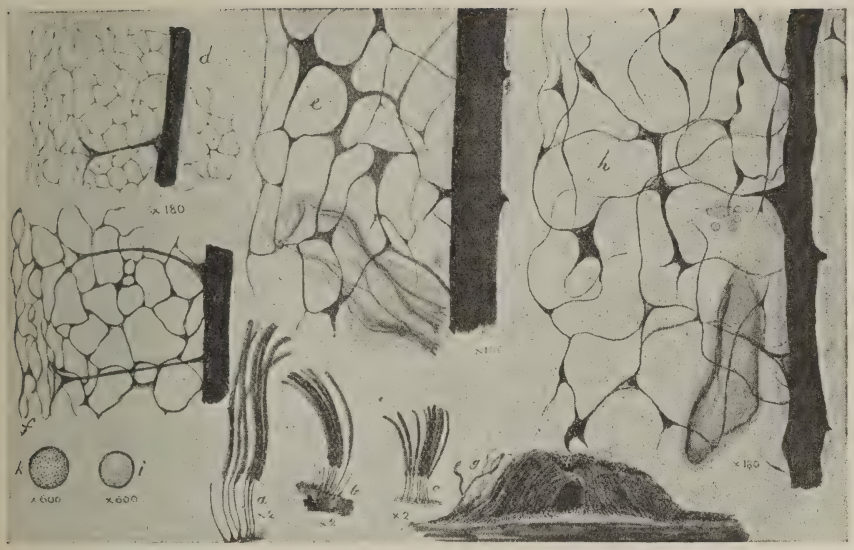


119. *a—d*, STEMONITIS FLAVOGENITA Jahn
e—g, S. FERRUGINEA Ehrenb.

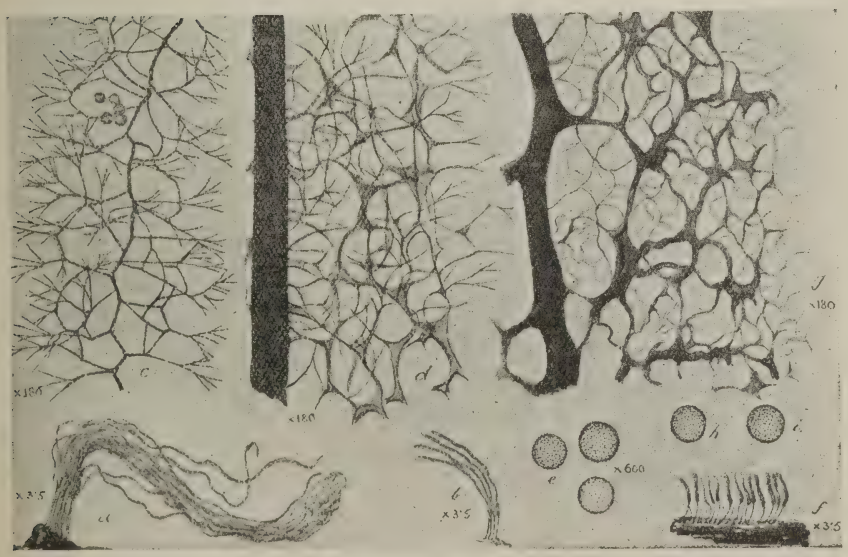


120.*a—g*, STEMONITIS HERBATICA Peck
h—l, S. PALLIDA Wingate

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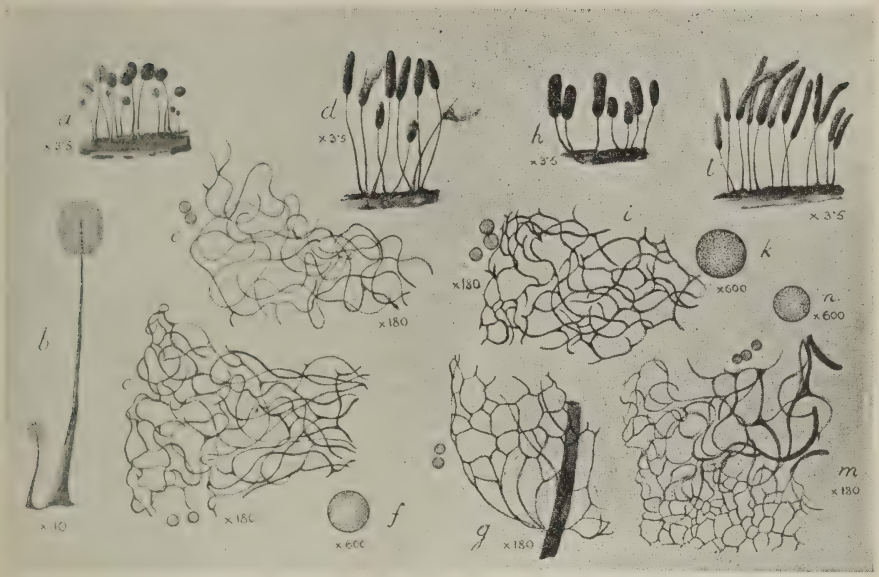


121. *a*—*i*, STEMONITIS SPLENDENS Rost.;
k, S. CONFLUENS Cooke & Ellis



122. *a*—*e*, COMATRICHA LONGA Peck;
f—*i*, C. IRREGULARIS Rex

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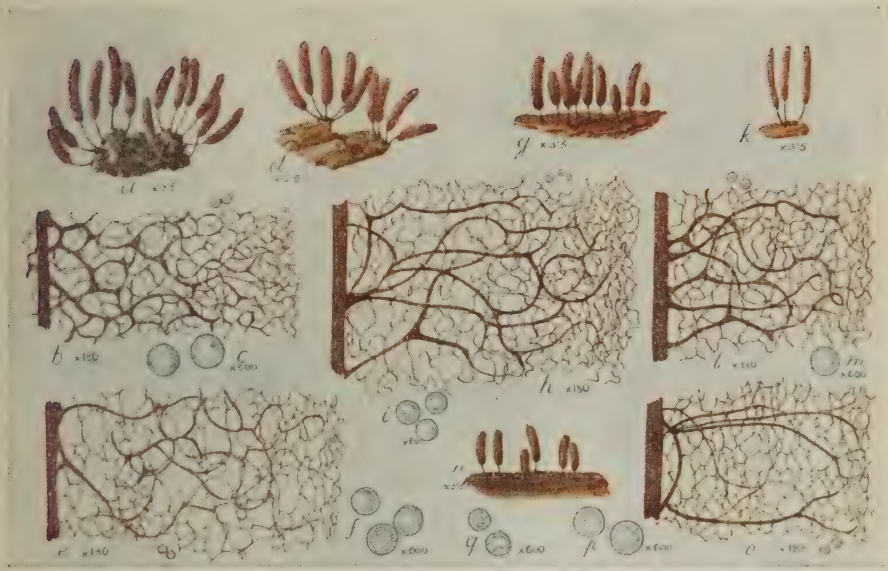


123. COMATRICHA NIGRA Schroeter

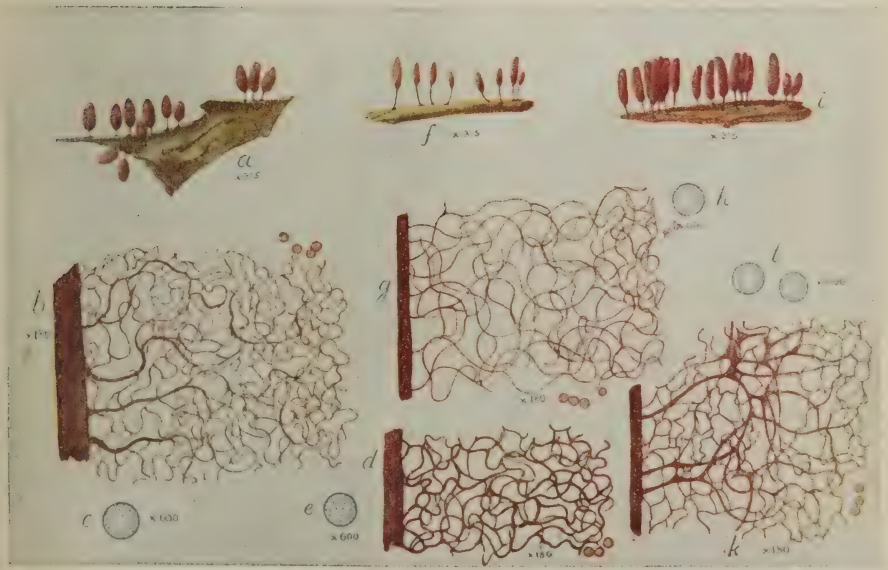


124. *a*—*g*, COMATRICHA LAXA Rost.;
h—*n*, C. ELEGANS Lister

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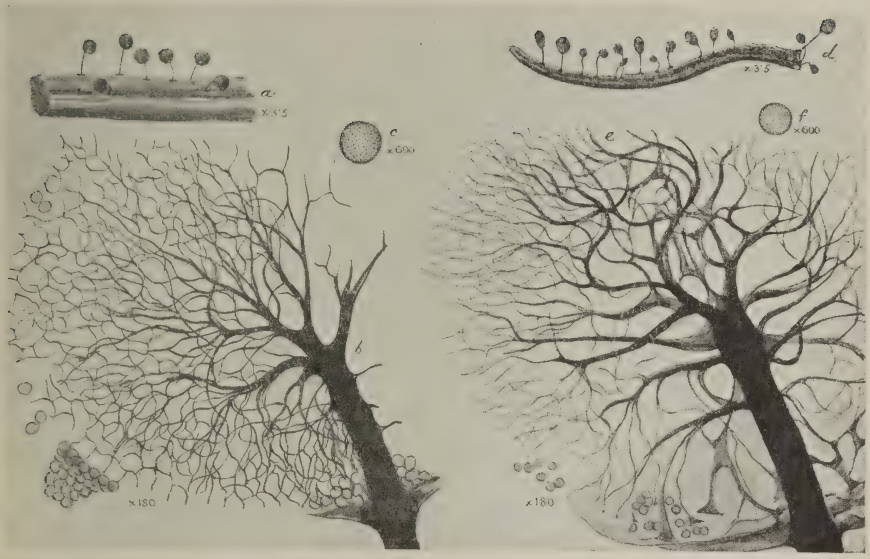


125. *a*—*c*, *k*—*m*, COMATRICHA TYPHOIDES Rost.
d—*f*, STEMONITIS HYPEROPTA Meylan
g—*i*, S. MICROSPORA G. Lister
n—*p*, S. FUSCA Roth. *q*, S. VIRGINIENSIS Rex



126. *a*—*e*, *i*—*l*, COMATRICHA PULCHELLA Rost.
f—*h*, C. TENERRIMA G. Lister

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127. *a—c*, COMATRICHA LURIDA Lister
d—f, C. RUBENS Lister



128. *a—e*, ENERTHENEMA PAPILLATA Rost.;
f—i, ECHINOSTELIUM MINUTUM De Bary

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129. LAMPRODERMA ARCYRIONEMA Rost.



130. LAMPRODERMA SCINTILLANS Morgan

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131. *a*—*g*, LAMPRODERMA COLUMBINUM Rost.
h, *i*, LEPTODERMA IRIDESCENS G. Lister



132. LAMPRODERMA VIOLACEUM Rost.

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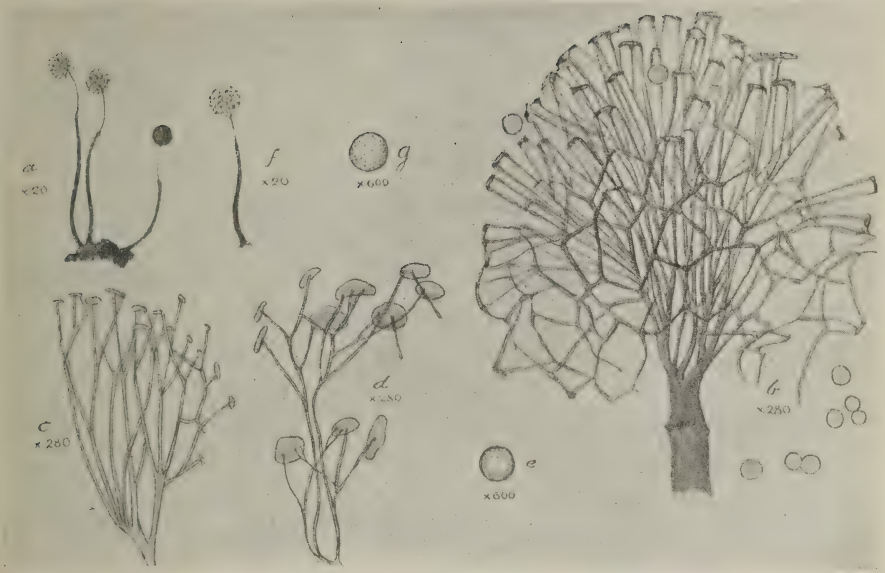


133. *a*—*e*, LAMPRODERMA CRIBRARIOIDES R.E.Fries ; *f*—*i*, L. ATROSPORUM Meylan

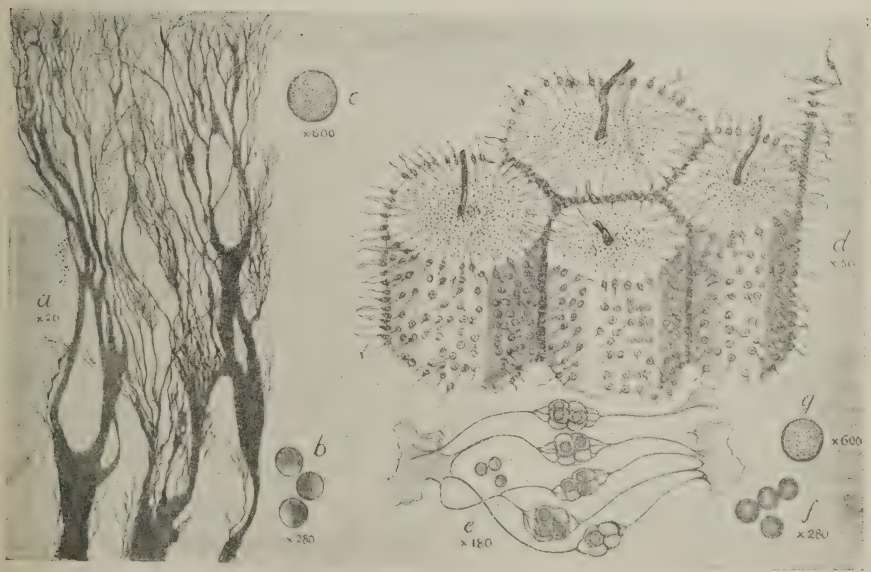


134. LAMPRODERMA ECHINULATUM Rost.

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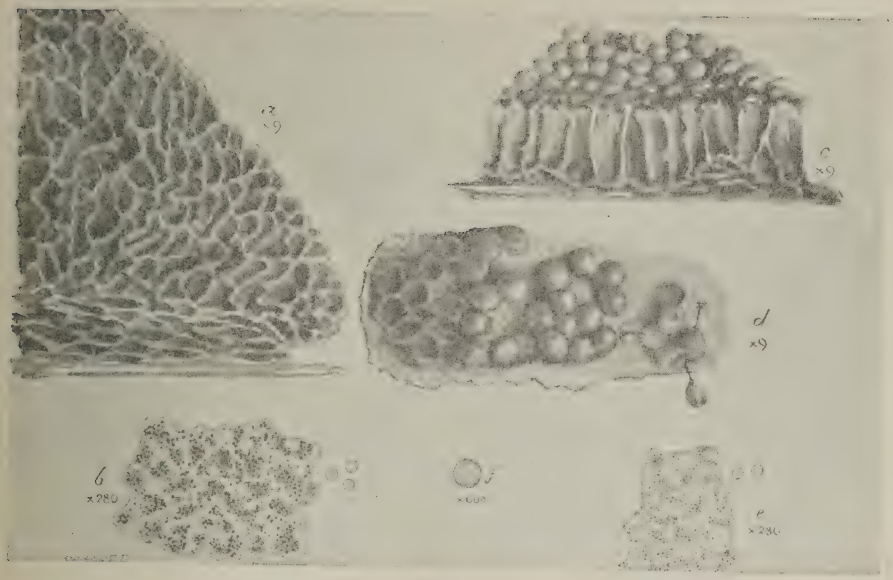


135. CLASTODERMA DEBARYANUM Blytt



136. *a*—*c*, AMAUROCHÆTE FULIGINOSA Macbride,
d—*g*, BREFELDIA MAXIMA Rost.

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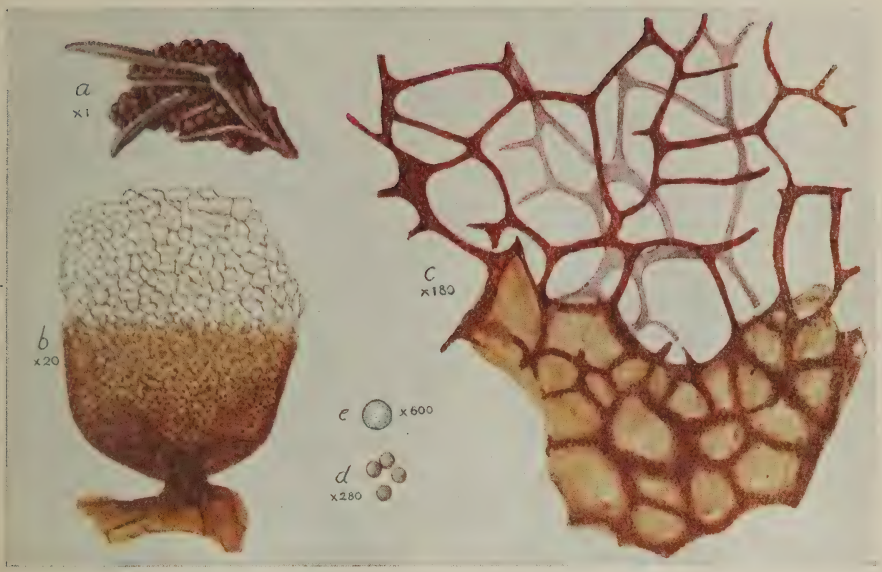


137. LINDBLADIA EFFUSA Rost.

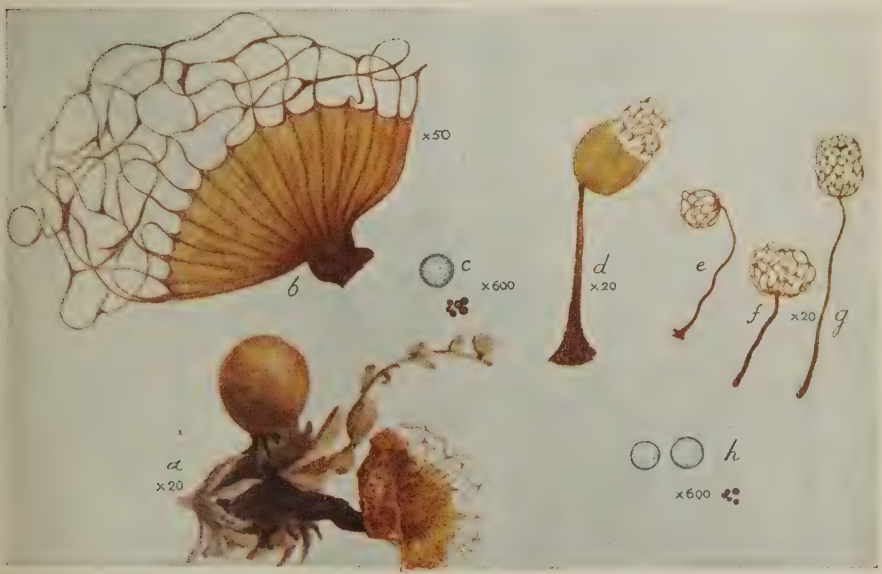


138. CRIBRARIA ARGILLACEA Pers.

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139. CRIBRARIA RUBIGINOSA Fries



140. *a*—*c*. CRIBRARIA RUFA Rost.
d—*h*, C. MINUTISSIMA Schwein.

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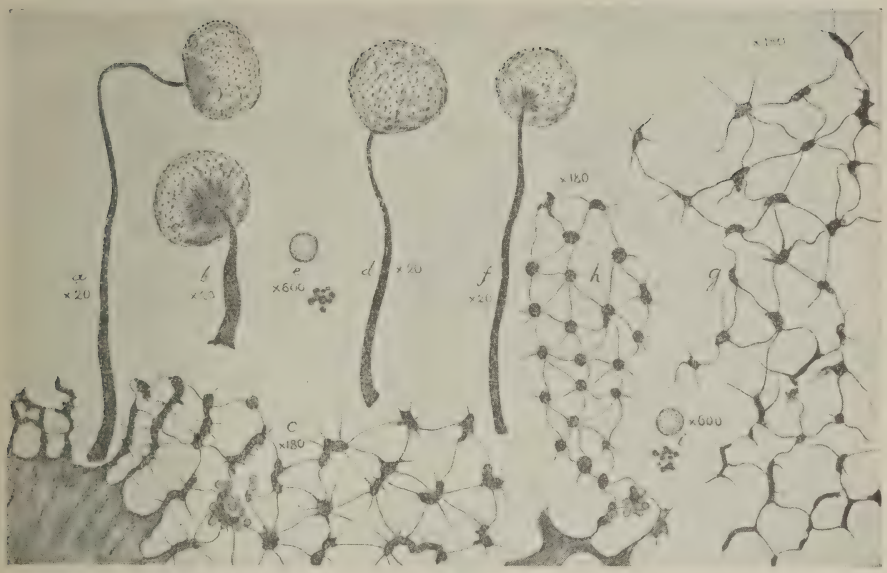


141. *a—d*, CRIBRARIA MACROCARPA Schrad.
e—g, C. SPLENDENS Pers.

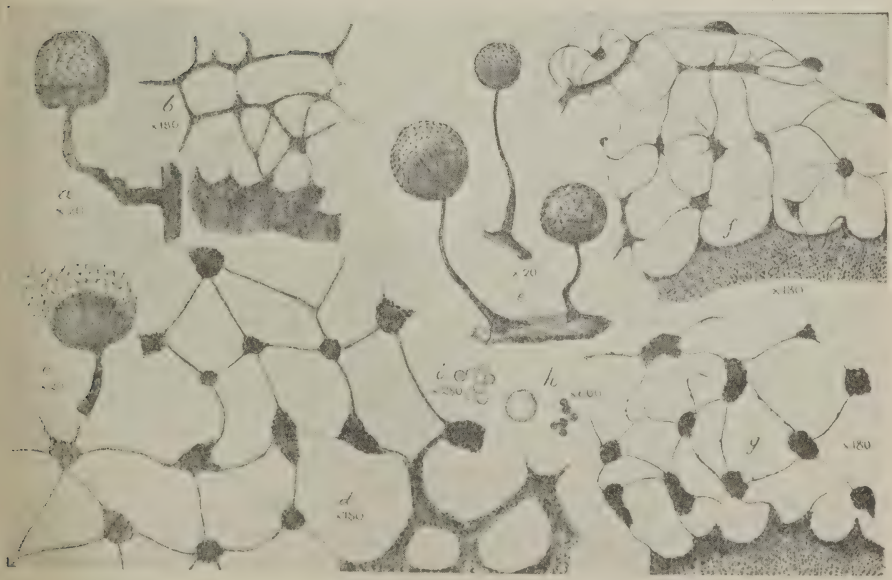


142. CRIBRARIA AURANTIACA Schrad.

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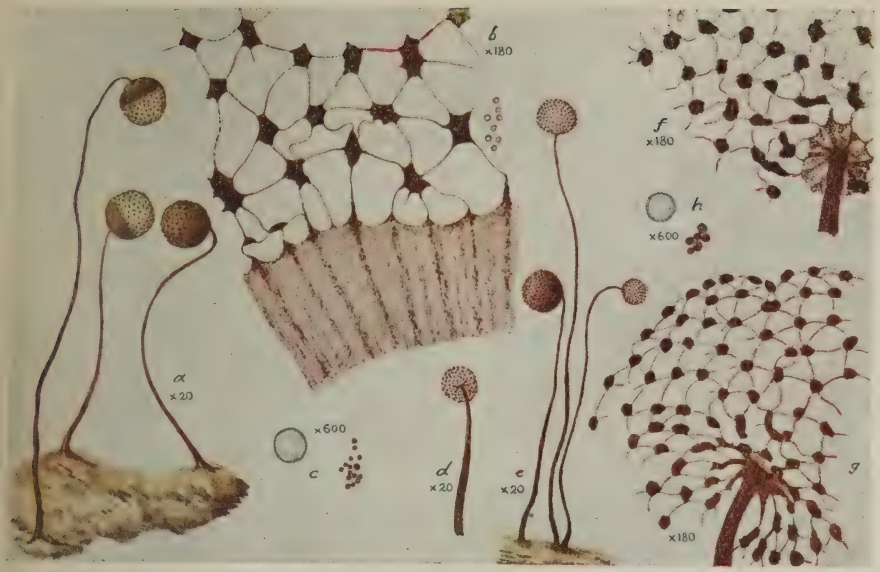


143. *a*—*e*, CRIBRARIA INTRICATA Schrader
f—*i*, C. TENELLA Schrader

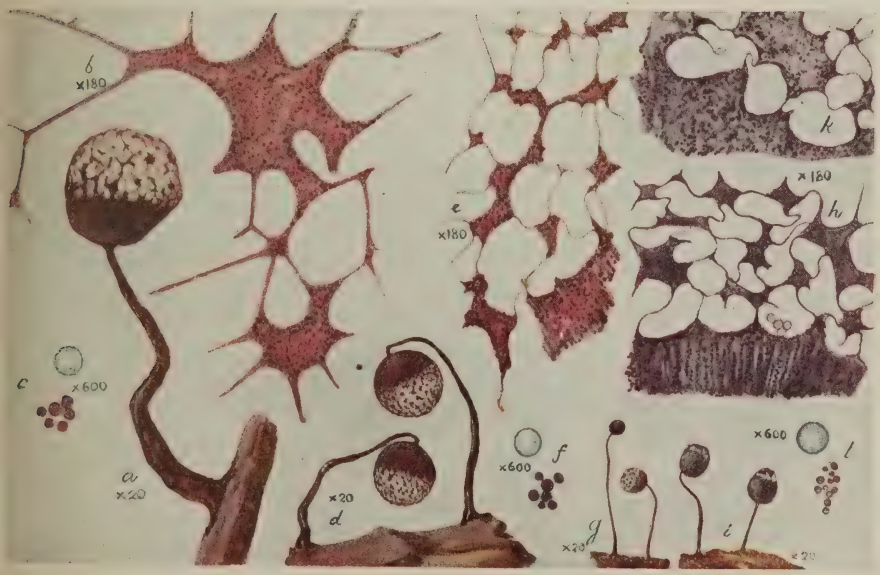


144. CRIBRARIA PYRIFORMIS Schrader

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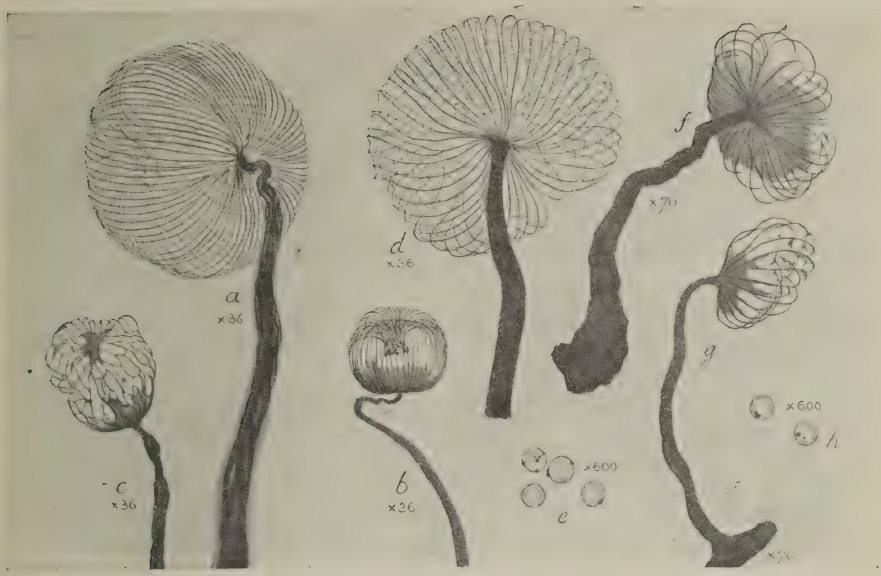


145. *a—c*, CRIBRARIA LANGUESCENS Rex
d—h, C. MICROCARPA Schrader

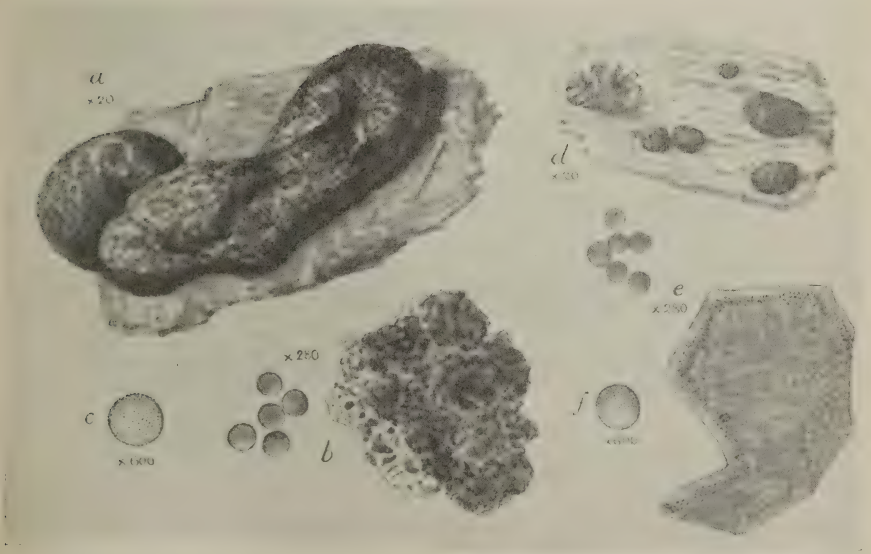


146. *a—e*, CRIBRARIA PURPUREA Schrader
d—i, C. ELEGANS Berk. & Curt.
g—i, C. VIOLACEA Rex

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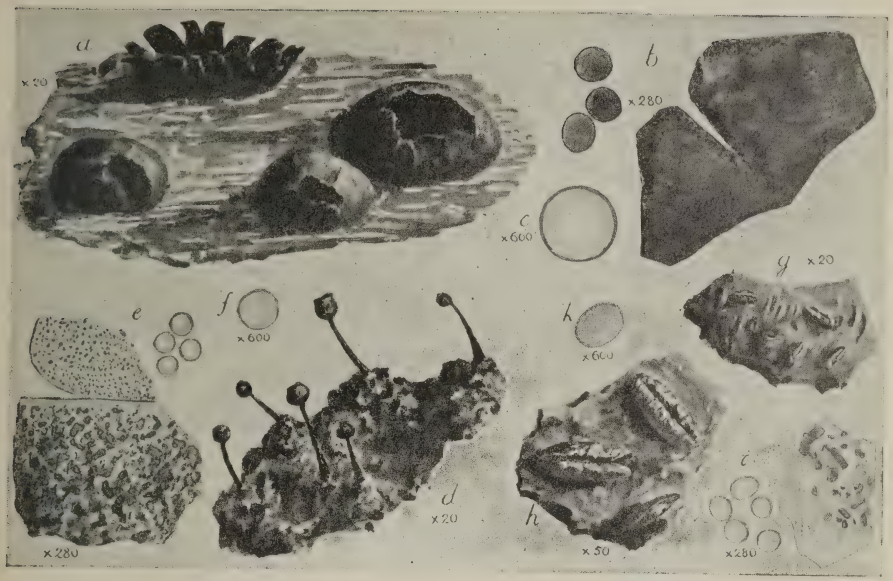


147. DICTYDIUM CANCELLATUM Macbride

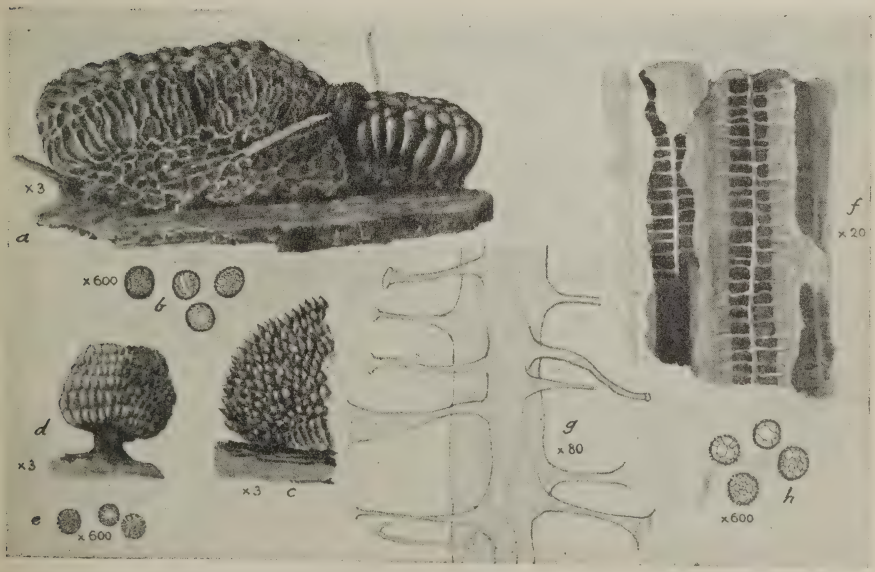


148. *a*—*c*, LICEA FLEXUOSA Pers.
d—*f*, L. MINIMA Fries

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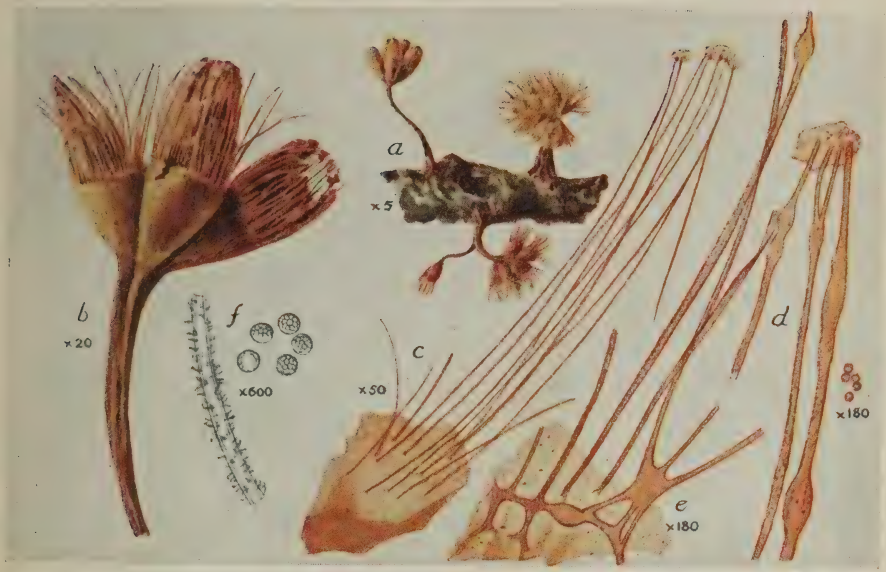


149. *a—c*, LICEA PUSILLA Schrader
d—f, ORCADELLA OPERCULATA Wingate
g—k, LICEA BIFORIS Morgan

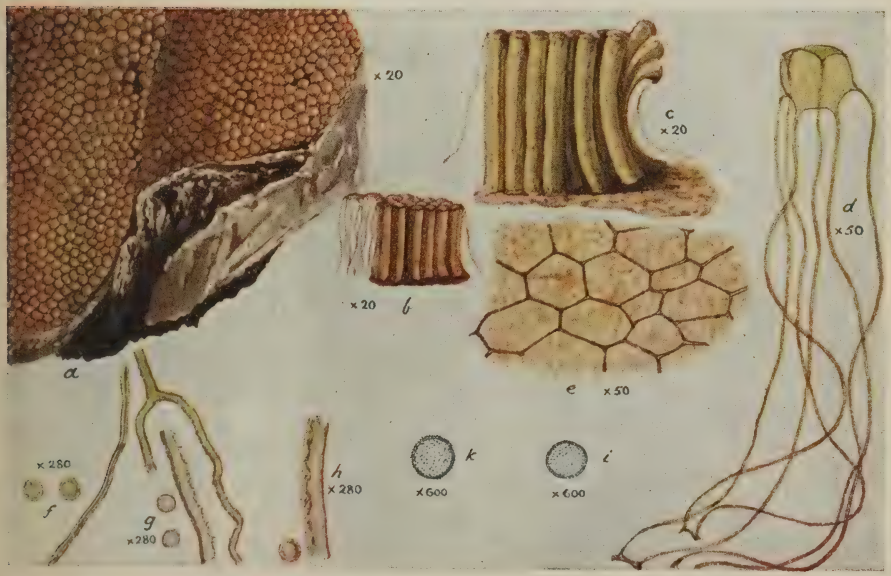


150. *a—c*, TUBIFERA FERRUGINOSA Gmelin
d—e, T. STIPITATA Macbride
f—h, T. CASPARYI Macbride

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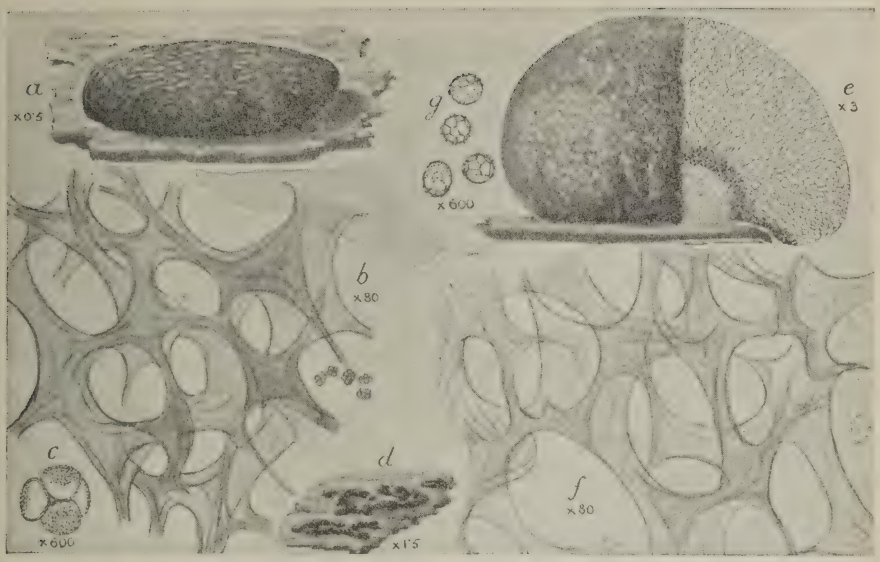


151. ALWISIA BOMBARDA Berk. & Broome



152. DICTYDIÆTHALIUM PLUMBEUM Rost.

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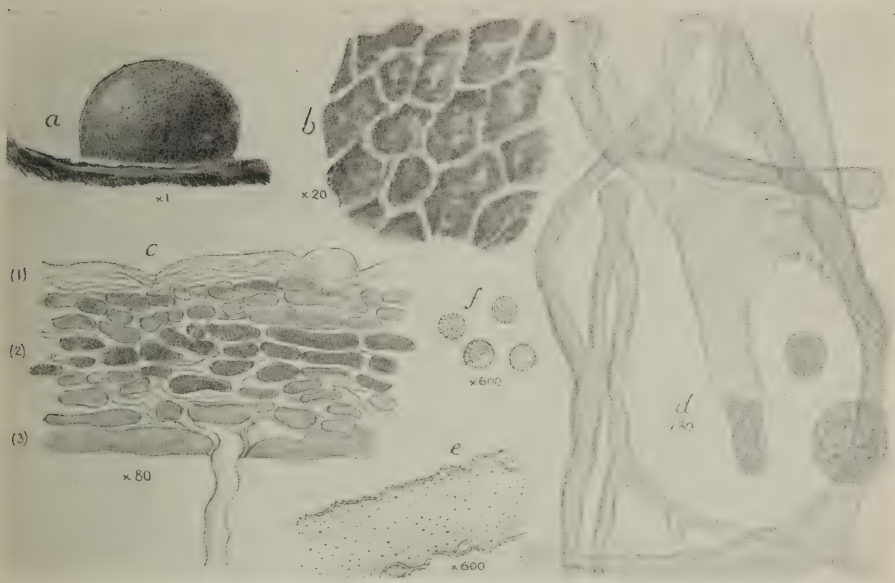


153. *a—d*, ENTERIDIUM OLIVACEUM Ehrenb.
e—g, E. ROZEANUM Wingate

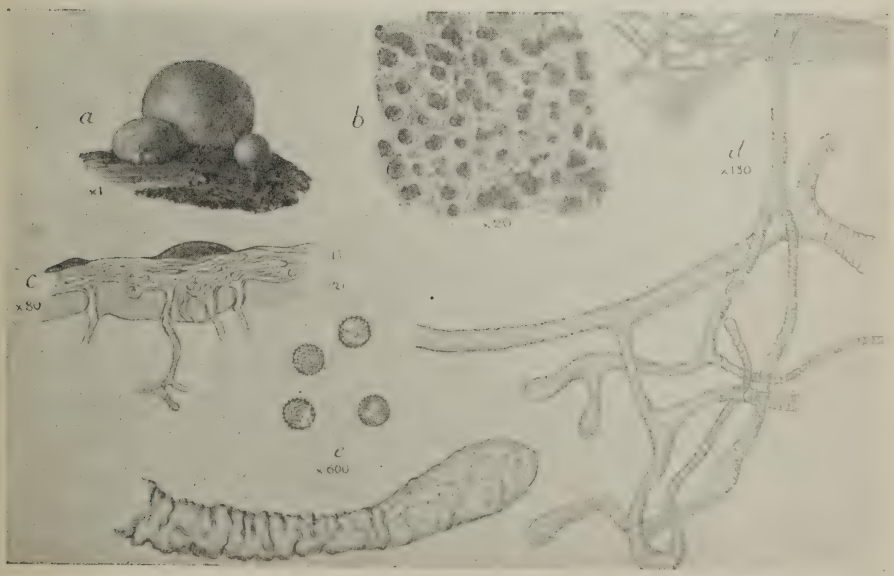


154. *a—c*, RETICULARIA LYCOPERDON Bull.
d—f, LICEOPSIS LOBATA Torrend

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155. LYCOGALA FLAVOFUSCUM Rost.

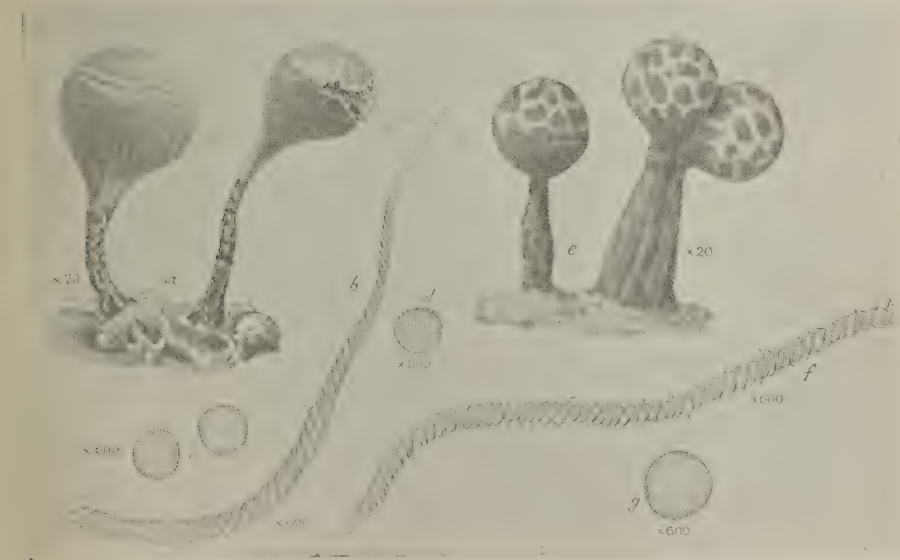


156. LYCOGALA EPIDENDRUM Fries

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157. LYCOGALA CONICUM Pers.



158. *a*—*d*, TRICHIA DECIPIENS Macbride
e—*g*, T. ERECTA Rex

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159. *a*, *b*, TRICHIA FAVOGINEA Pers.
c, *d*, T. SCABRA Rost.



160. *a*, *b*, TRICHIA PERSIMILIS Karsten
c, *d*, T. AFFINIS de Bary

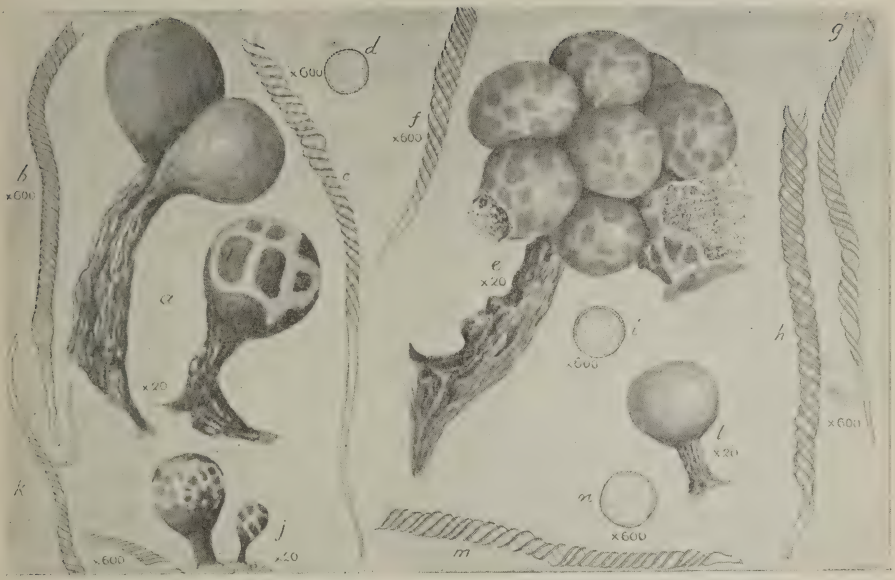
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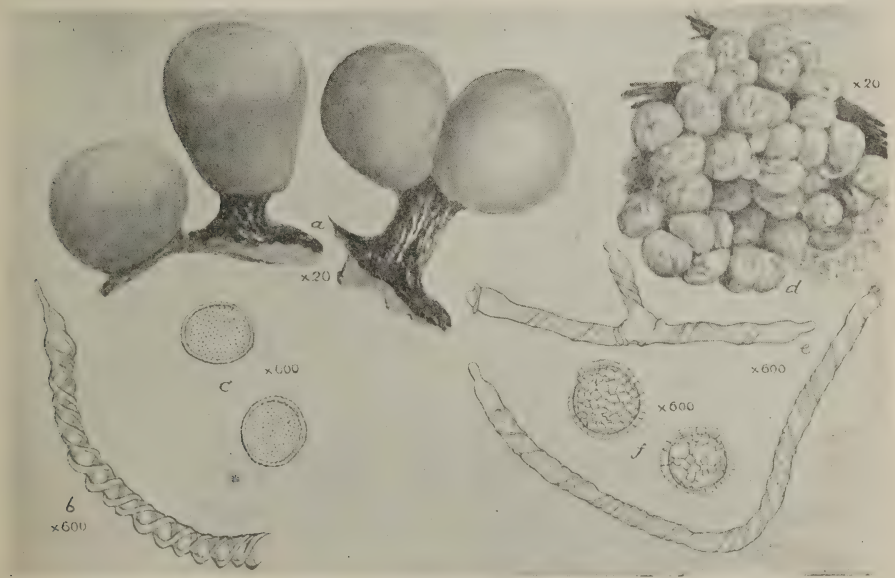
161. *a, b,* TRICHIA VERRUCOSA Berk
c—e, T. LUTESCENS Lister



162. *a, b,* TRICHIA CONTORTA Rost.
c, d, TRICHIA ALPINA Meylan



163. *a—k*, TRICHIA BOTRYTIS Pers.
l—n, T. SUBFUSCA Rex

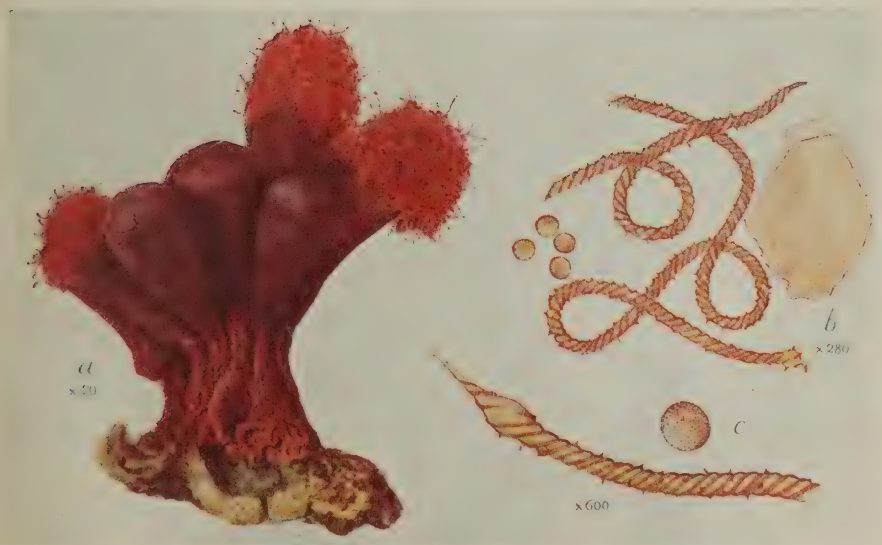


164. *a—c*, TRICHIA VARIA Pers.
d—f, OLIGONEMA NITENS Rost.

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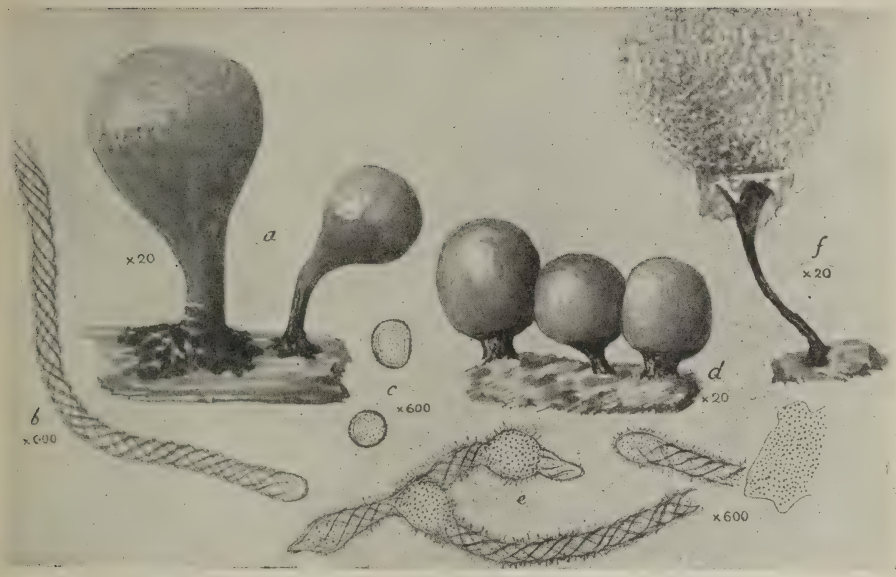


165. *a—c*, OLIGONEMA FLAVIDUM Peck
d—f, CALONEMA AUREUM Morgan



166. HEMITRICHIA VESPARIUM Macbr.

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167. HEMITRICHIA CLAVATA Rost.



168. *a*, *b*, HEMITRICHIA LEIOCARPA Lister
c—*e*, H. ABIETINA Lister

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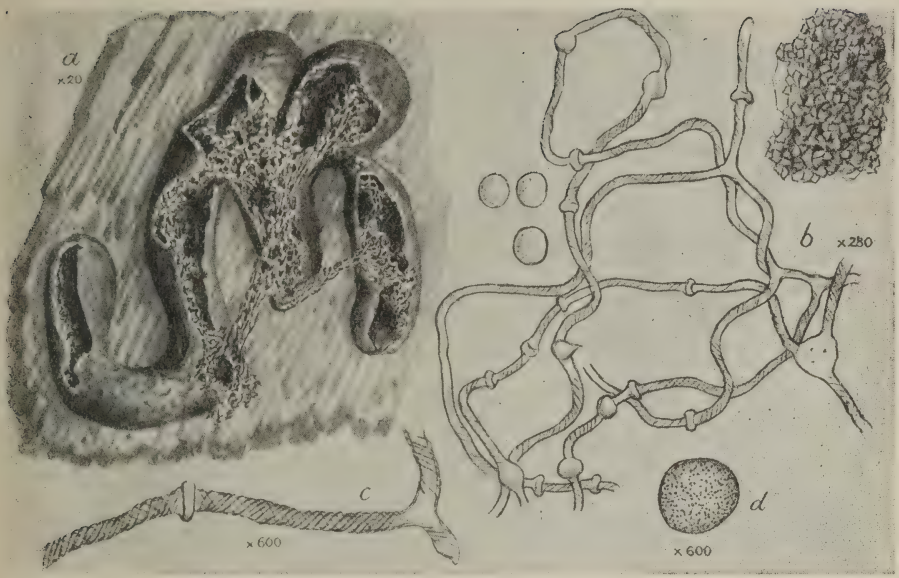


169. HEMITRICHIA CHRYSOSPORA Lister

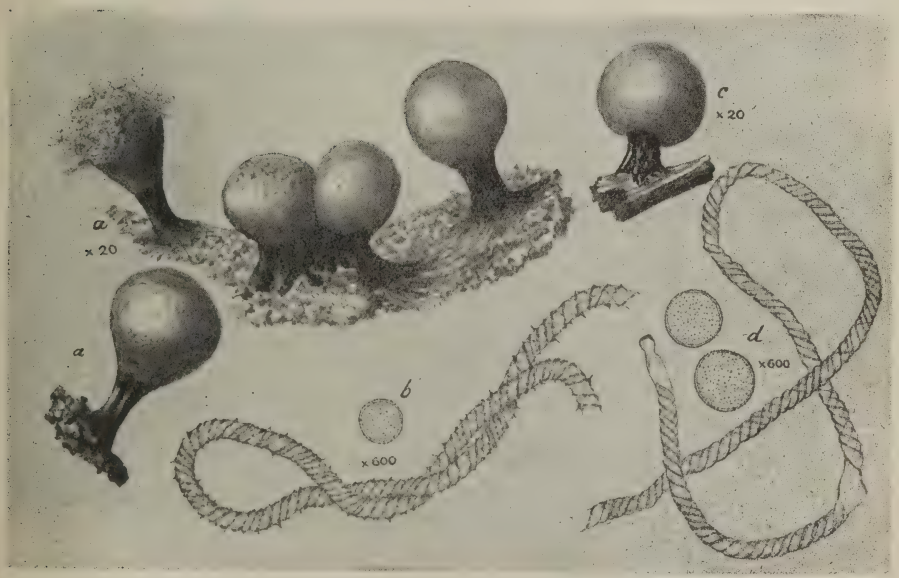


170. *a—c*, HEMITRICHIA SERPULA Rost.
d, *e*, CORNUVIA SERPULA Rost.

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171. HEMITRICHIA KARSTENII Lister

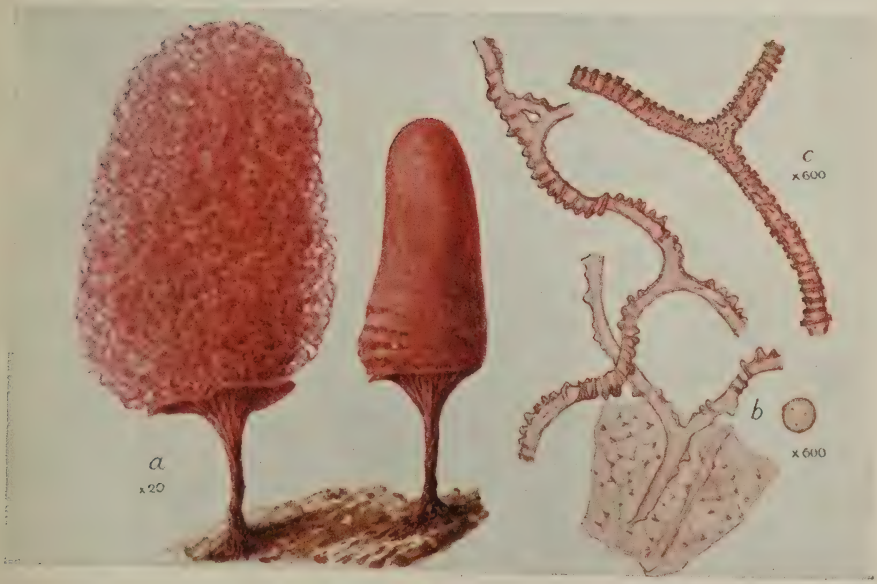


172. *a*, *b*, HEMITRICHIA INTORTA Lister
c, *d*, H. LEIOTRICHA Lister

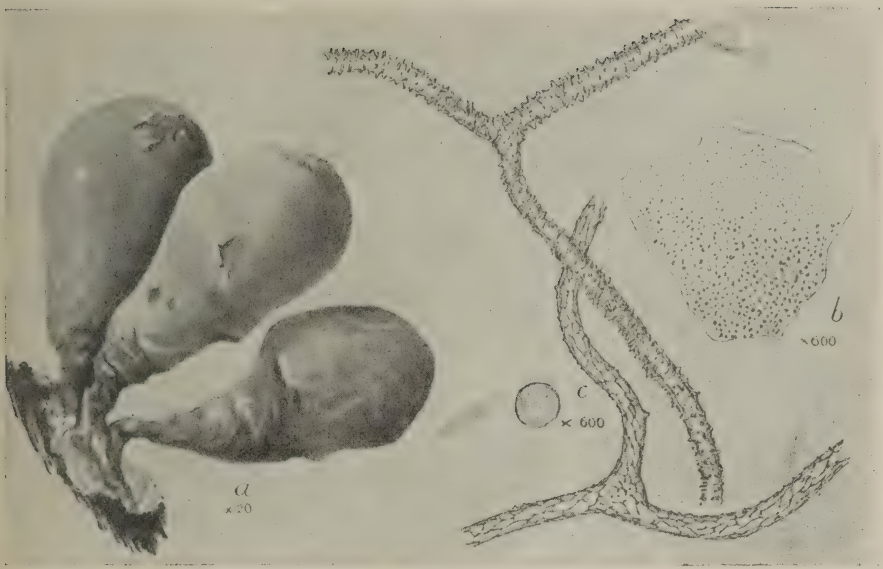
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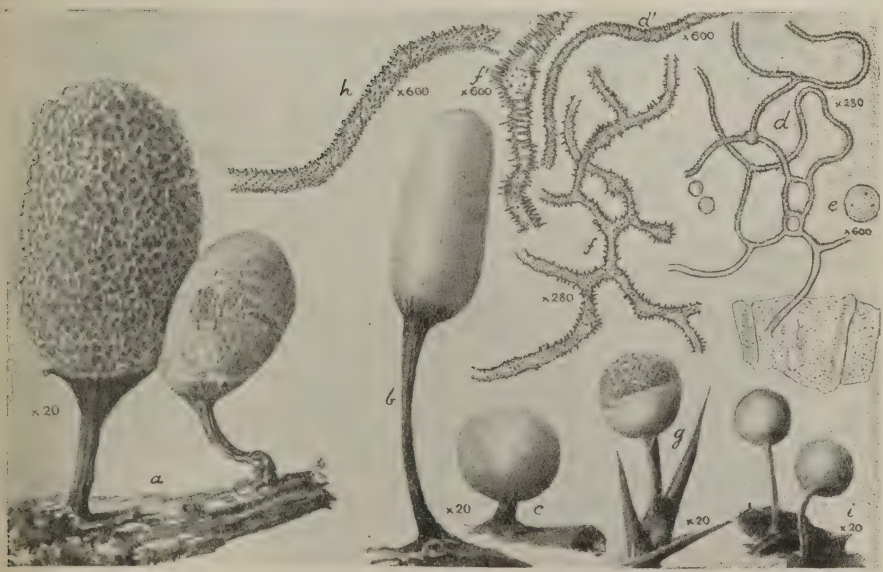
173. ARCYRIA FERRUGINEA Sauter



174. ARCYRIA DENUDATA Wettstein

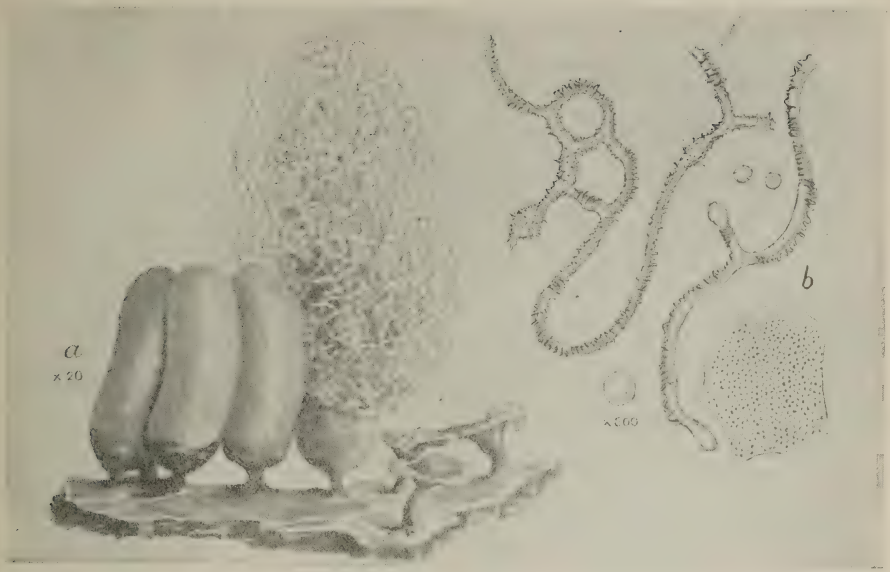


175. ARCYRIA VERSICOLOR Phill.



176. *a*—*e*, ARCYRIA CINEREA Pers.
f, *f*', A. POMIFORMIS Rost.;
g—*i*, A. GLOBOSA Schwein.

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177. ARCYRIA INCARNATA Pers.

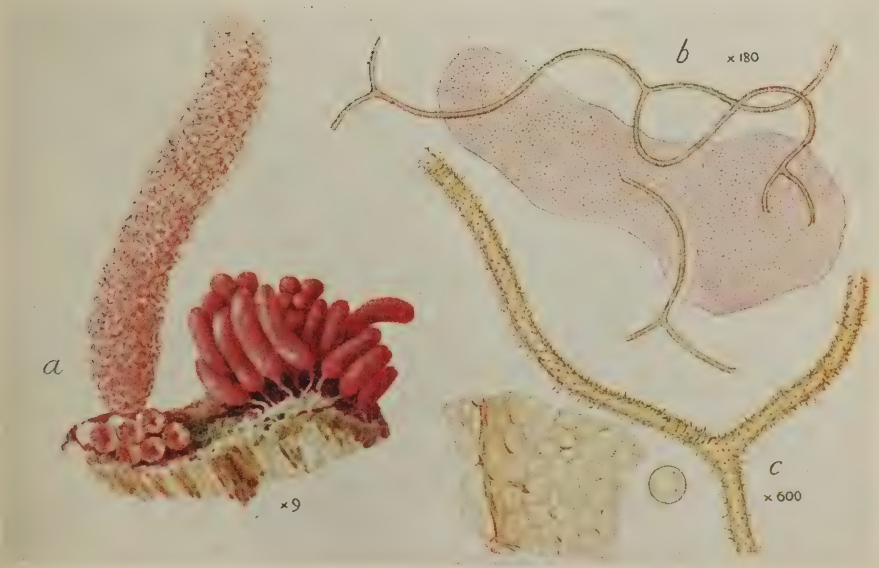


178. ARCYRIA STIPATA Lister

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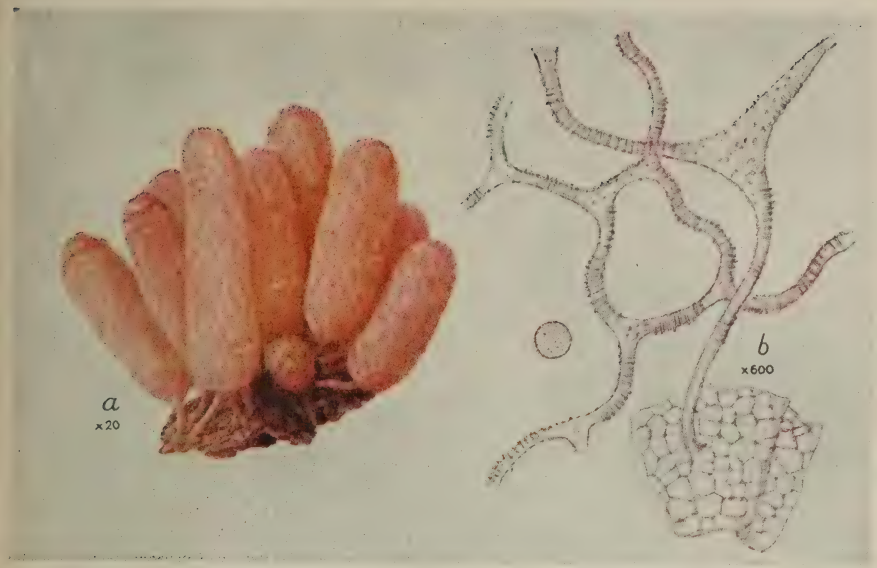


179. ARCYRIA NUTANS Grev.

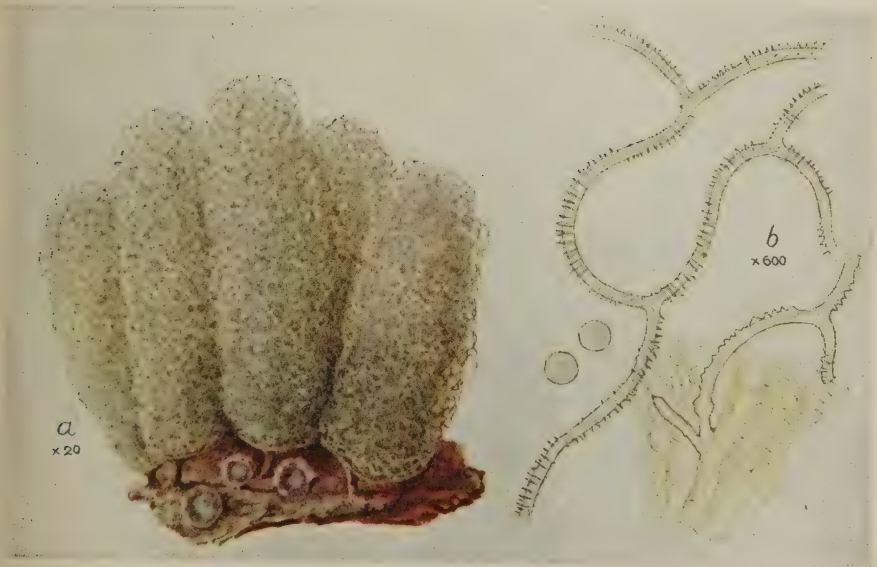


180. ARCYRIA OERSTEDTII Rost.

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181. ARCYRIA INSIGNIS Kalchbr. & Cooke

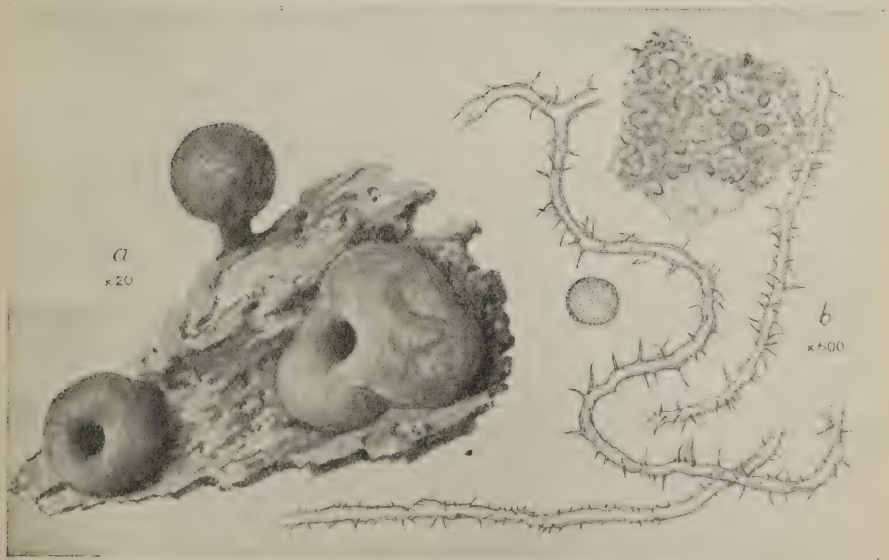


182. ARCYRIA GLAUCA Lister

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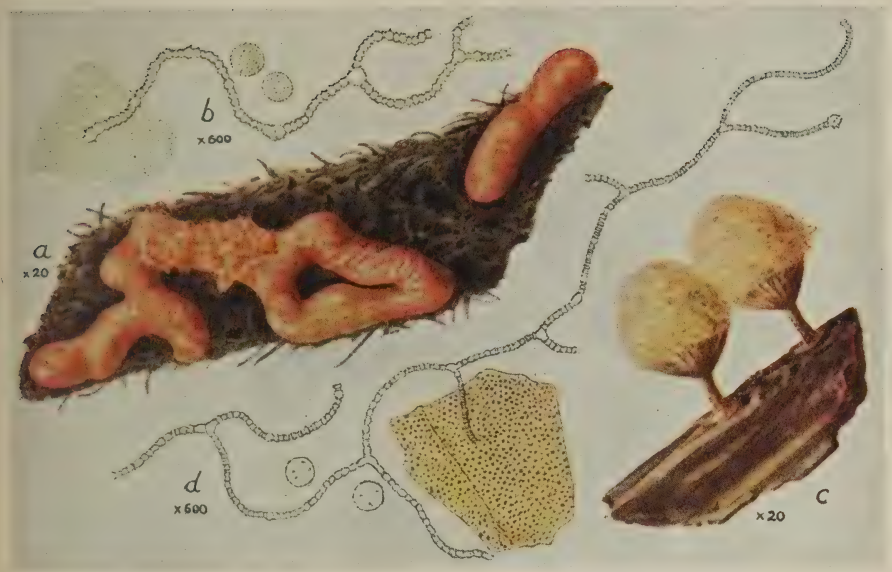


183. LACHNOBOLUS CONGESTUS Lister



184. PERICHÆNA CHRYSOSPERMA Lister

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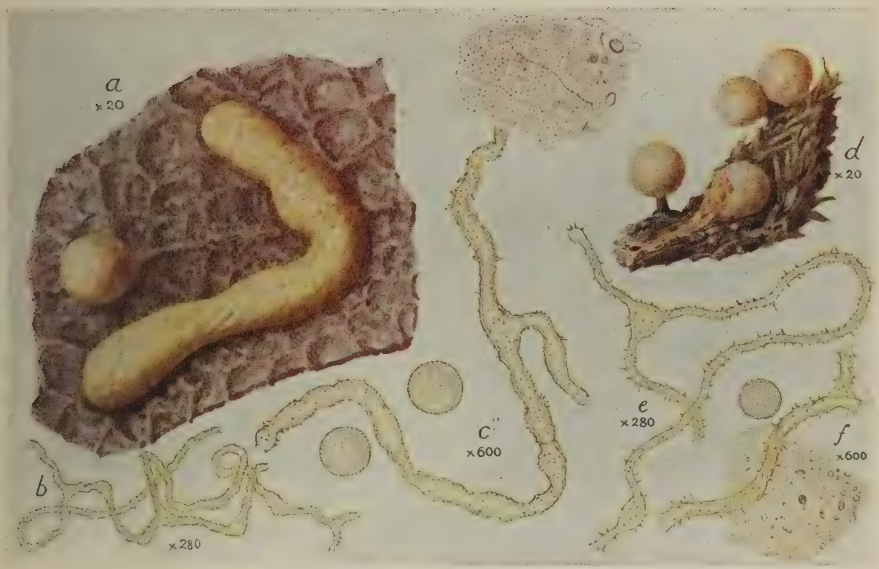


185. *a*, *b*, PERICHÆNA MICROSPORA Penzig & Lister
c, *d*, ARCYRIA ANNULIFERA Lister & Torrend

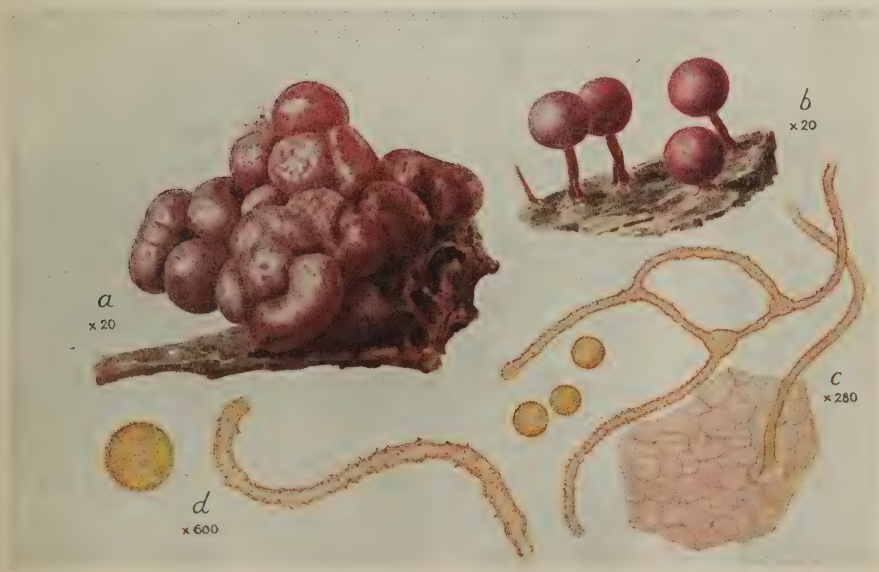


186. PERICHÆNA CORTICALIS Rost.

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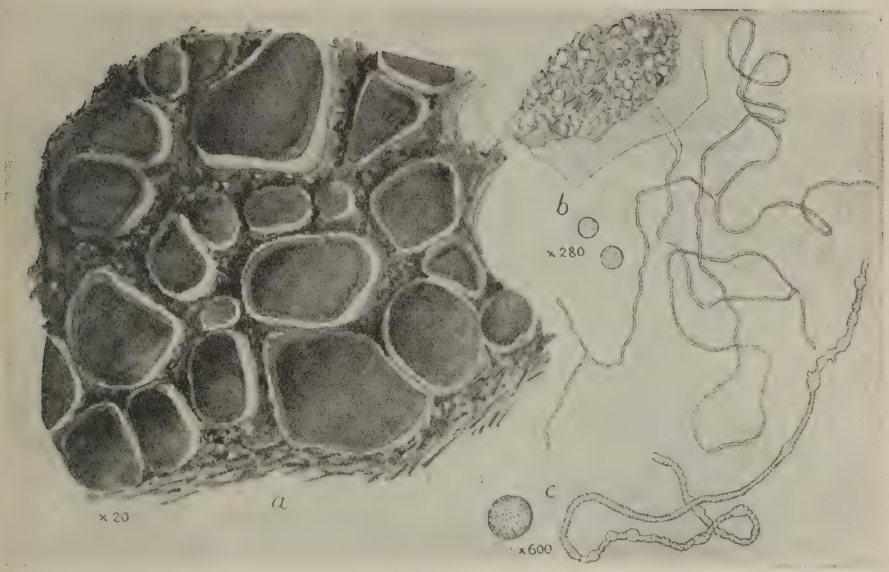


187. *a—c*, PERICHÆNA VERMICULARIS Rost.
d—f, HEMITRICHIA MINOR G. Lister

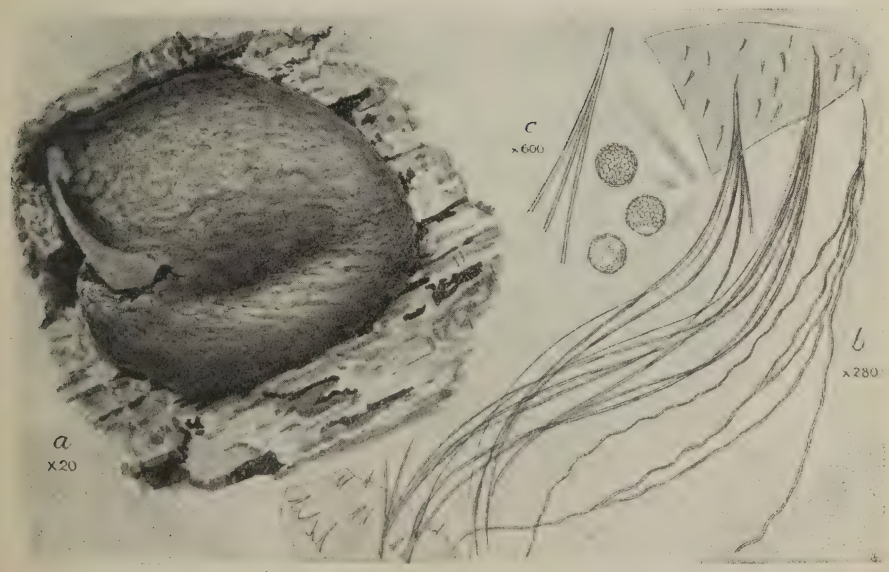


188. PERICHÆNA PULCHERRIMA Petch

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189. PERICHÆNA DEPRESSA Libert

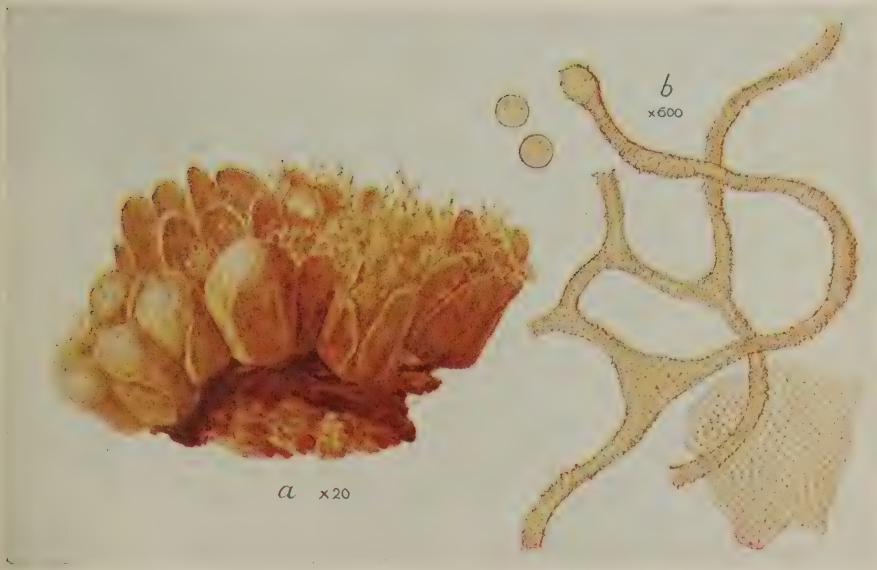


190. DIANEMA DEPRESSUM Lister

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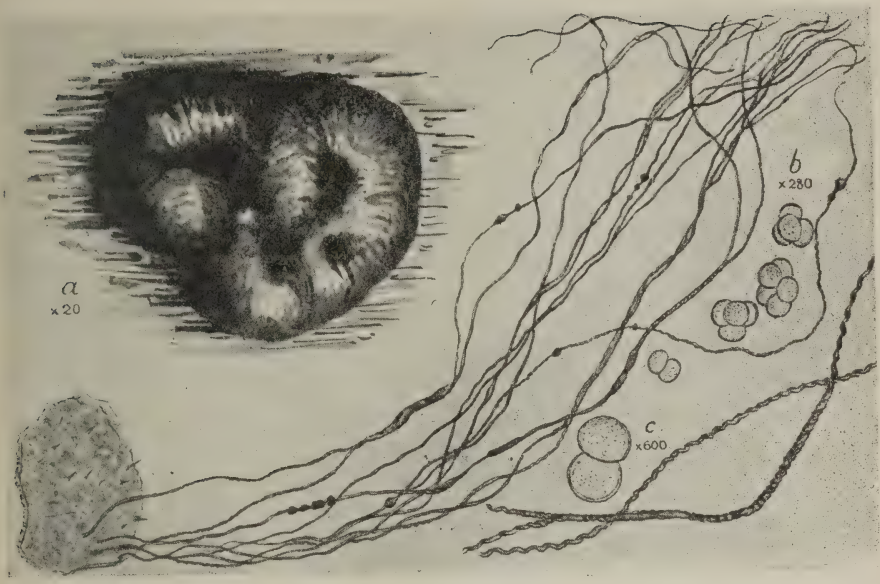


191.*a*—*c*, DIANEMA HARVEYI Rex
d—*f*, LISTERELLA PARADOXA Jahn

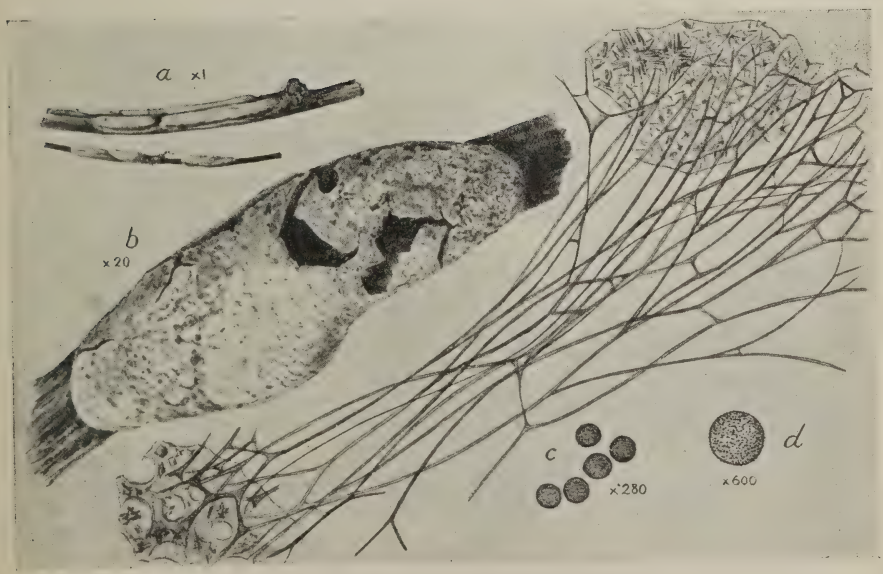


192. ARCYRIA OCCIDENTALIS Lister

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193. DIANEMA CORTICATUM Lister



194. DIDYMIUM WILCZEKII Meylan

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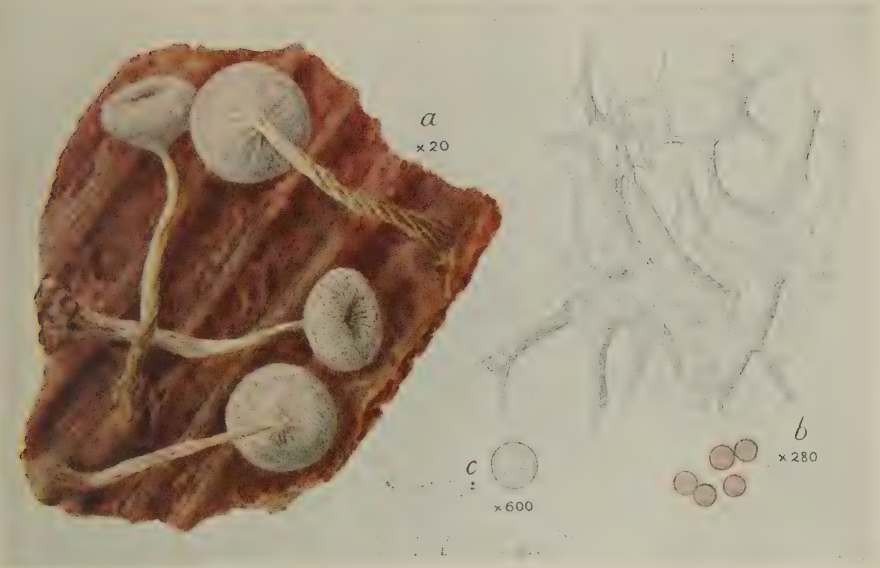


195. PROTOTRICHIA METALLICA Mass.



196. MARGARITA METALLICA Lister

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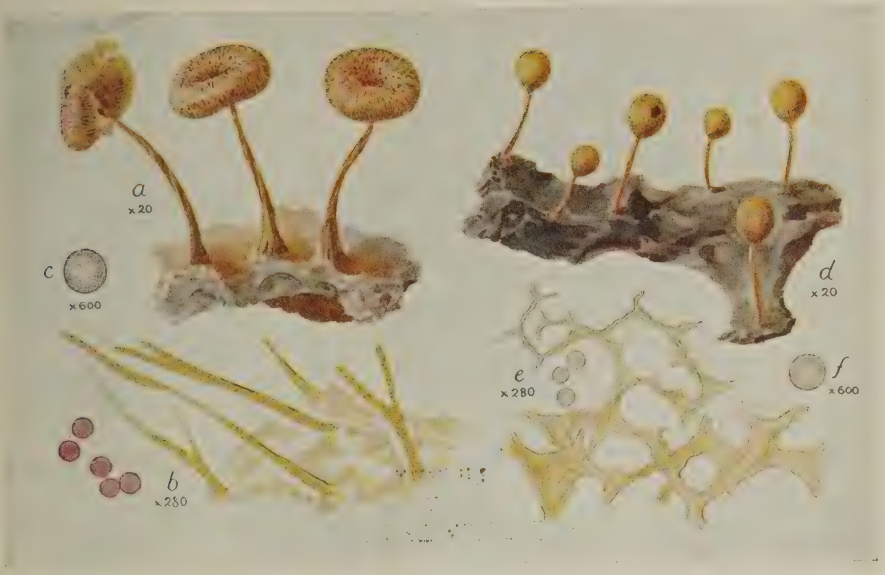


197. PHYSARUM JAVANICUM Racib.



198. PHYSARINA ECHINOCEPHALA v. Höhnel

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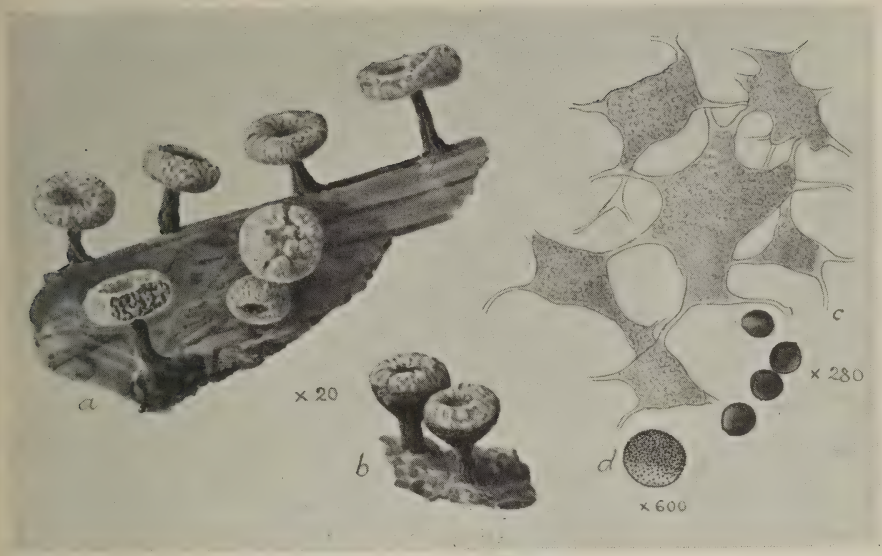


199. *a*—*c*. PHYSARUM RIGIDUM G. Lister
d—*f*, P. GALBEUM Wingate



200. PHYSARUM VIRIDE Pers. VAR. BETHELII G. Lister

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201. PHYSARUM MELANOSPERMUM Sturgis



202. *a—c*, PHYSARUM OVISPORUM G. Lister
d—f, FULIGO MEGASPORA Sturgis

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203. PHYSARUM DIGITATUM G. Lister & Farquharson

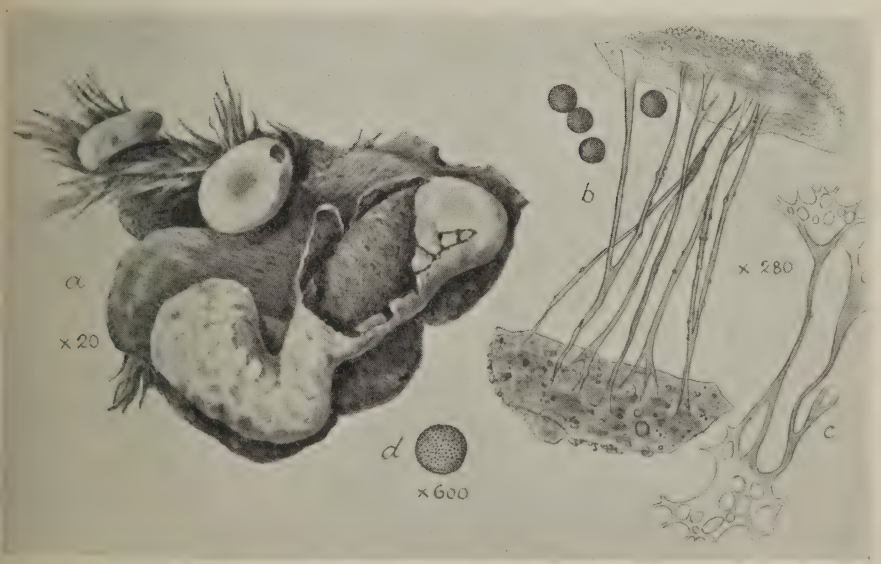


204. PHYSARUM CARNEUM G. Lister & Sturgis

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205. CRATERIUM RUBRONODUM G. Lister

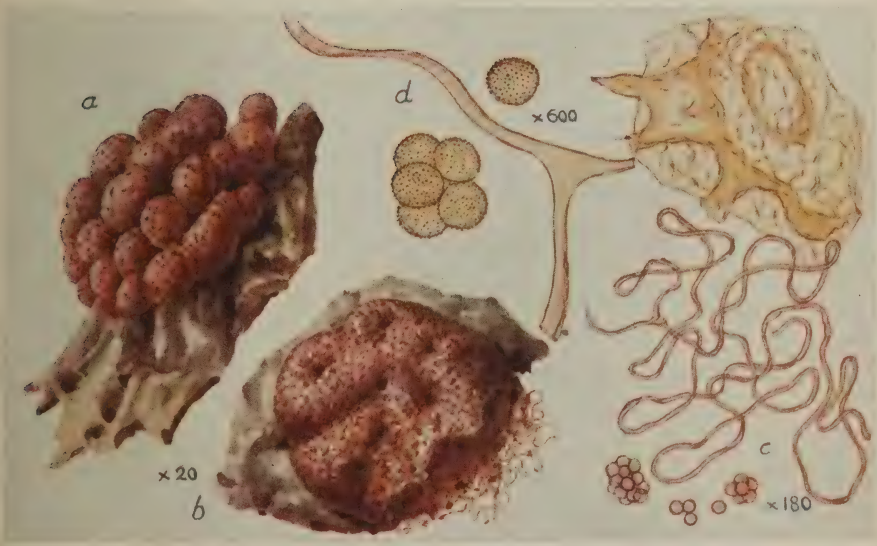


206. DIDERMA ARBOREUM G. Lister & Petch

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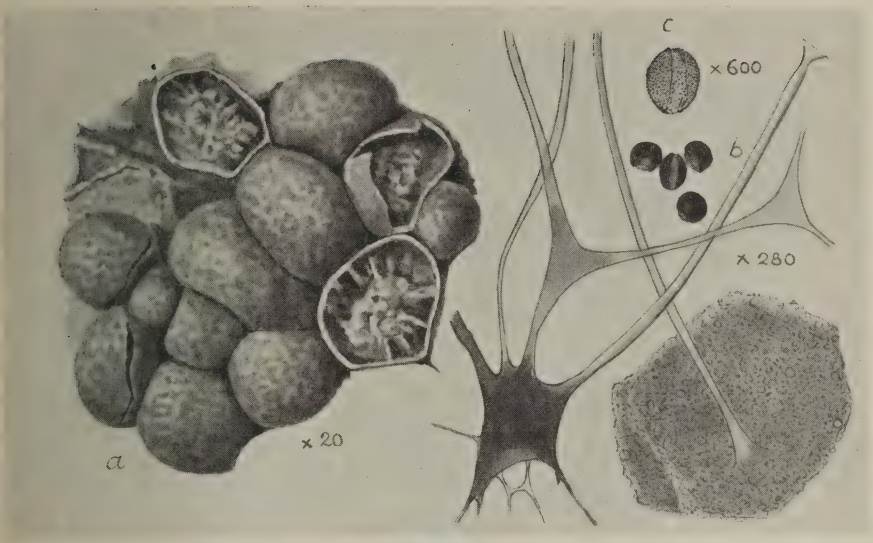


207. DIDERMA MONTANUM Meylan

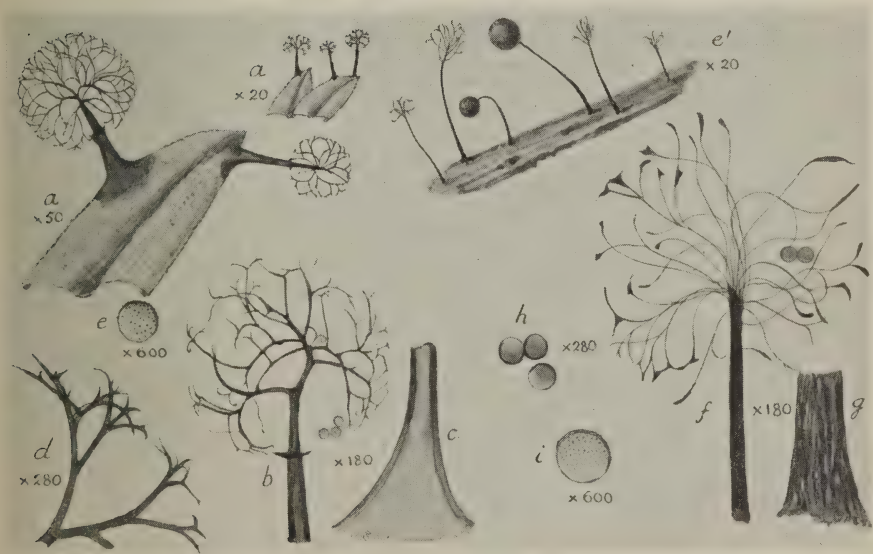


208. MINAKATELLA LONGIFILA G. Lister

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209. DIDERMA ANTARCTICA Sturgis

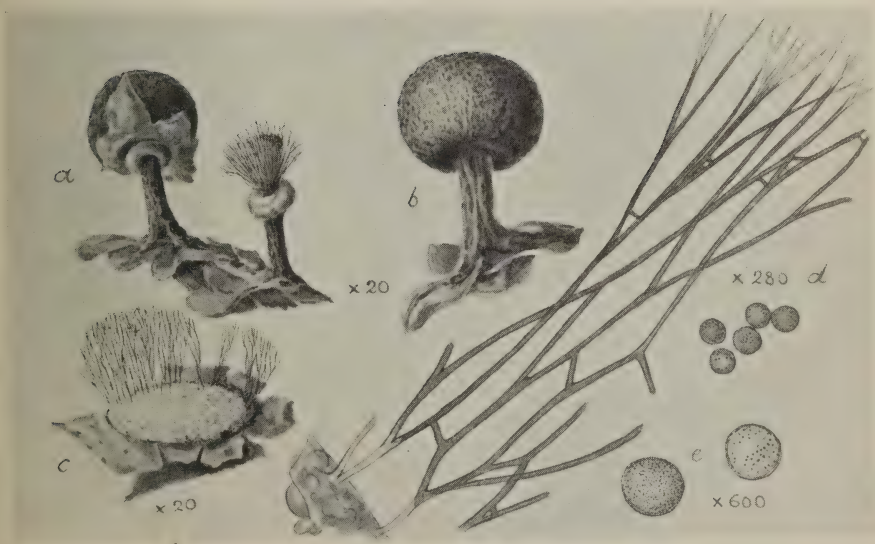


210. *a—e*, COMATRICHA CORNEA G. Lister & Cran
e'—i, C. FIMBRIATA G. Lister & Cran

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211. DIACHAEA RADIATA G. Lister & Petch

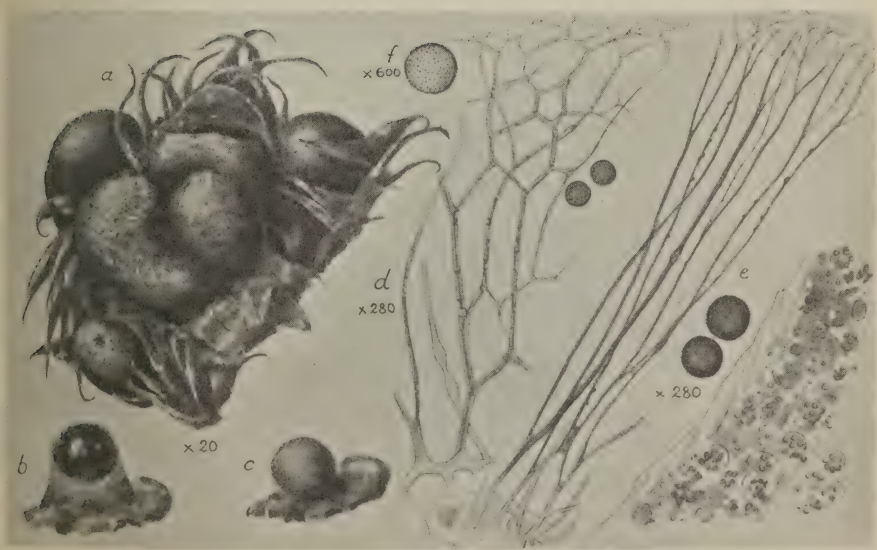


212. DIACHAEA CERIFERA G. Lister

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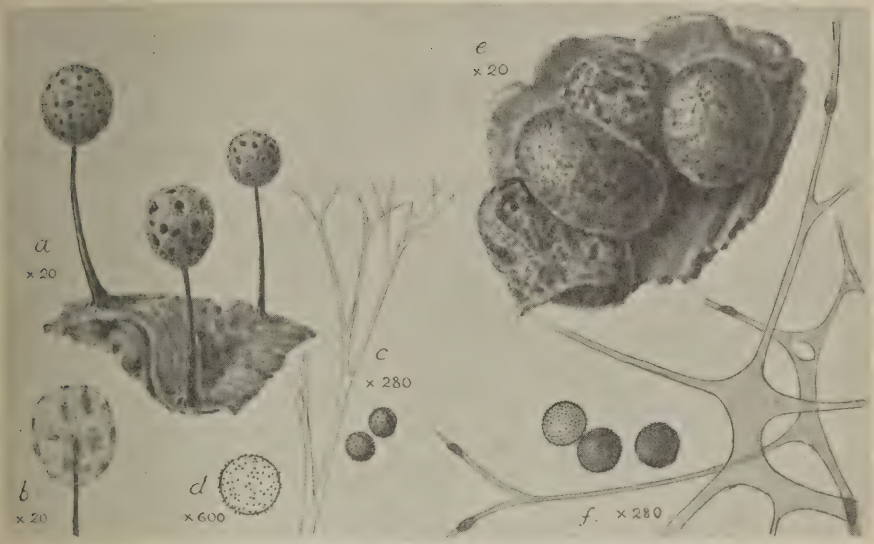


213. DIDYMIUM ANOMALUM Sturgis

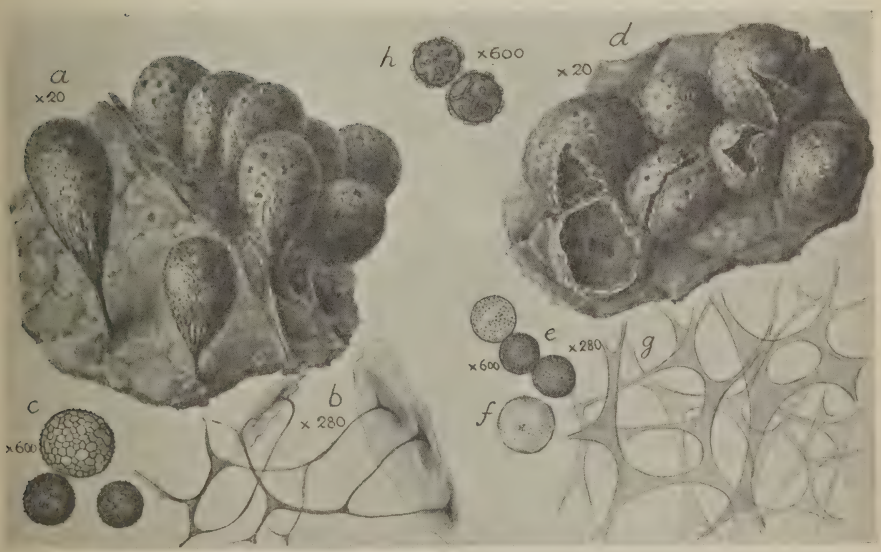


214. COLLODERMA OCULATUM (Lippert) G. Lister

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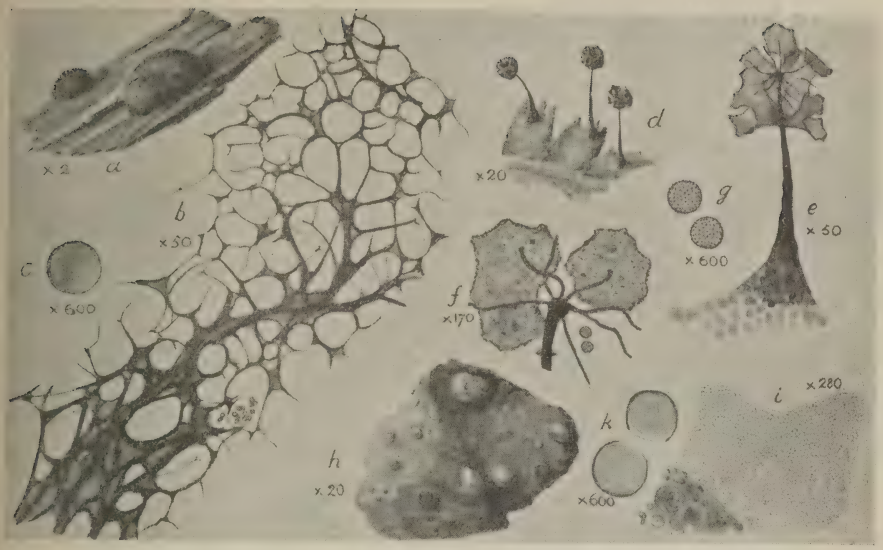


215. *a* to *d*. LAMPRODERMA GULIELMÆ Meylan
e, *f*. L. INSESSUM G. Lister

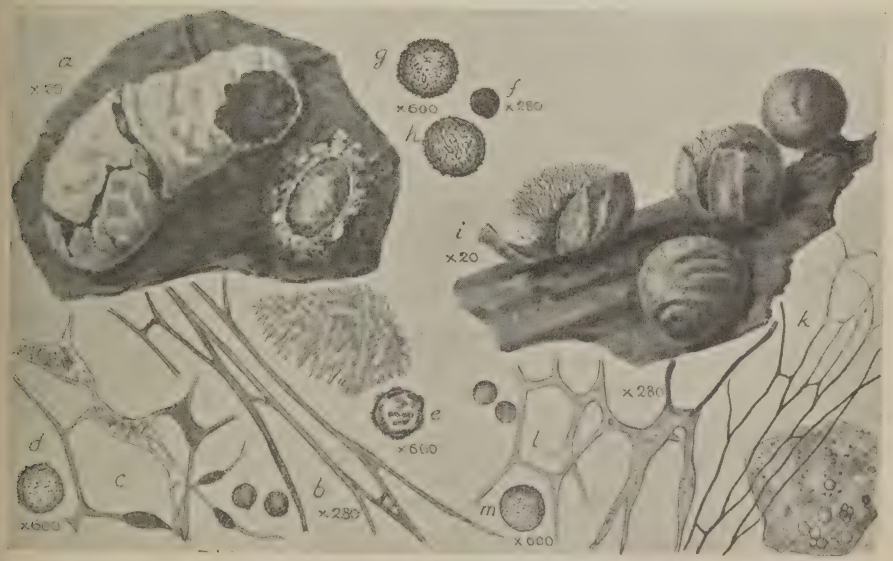


216. *a* to *c*. LAMPRODERMA ATROSPORUM *var*. ANGLICUM G. Lister & Howard
d to *g*. L. ATROSPORUM *var*. DEBILE G. Lister & Howard
h. L. CRIBRARIOIDES R. E. Fries *var*. CRISTATUM G. Lister

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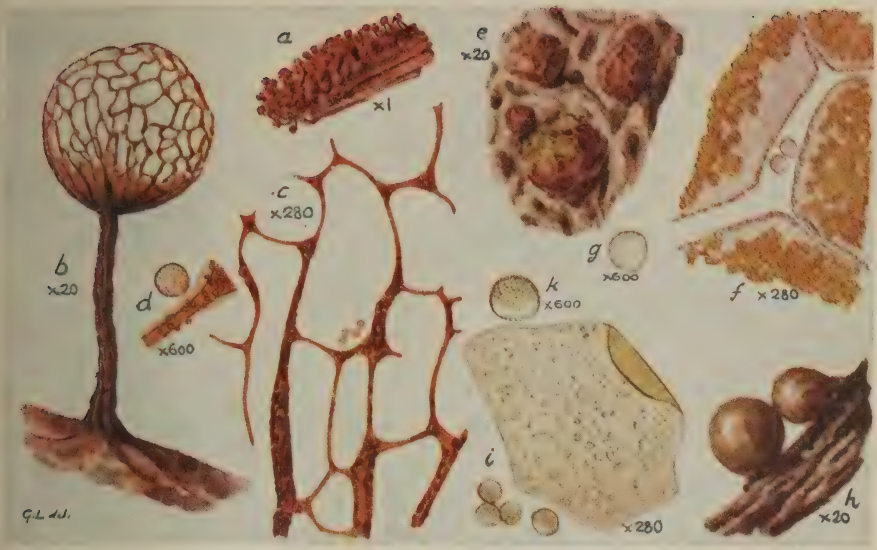


217. *a—c*, AMAUROCHAETE CRIBROSA (Fries) Sturgis
d—g, BARBEYELLA MINUTISSIMA Meylan
h—k, HYMENOBOLINA PARASITICA Zukal

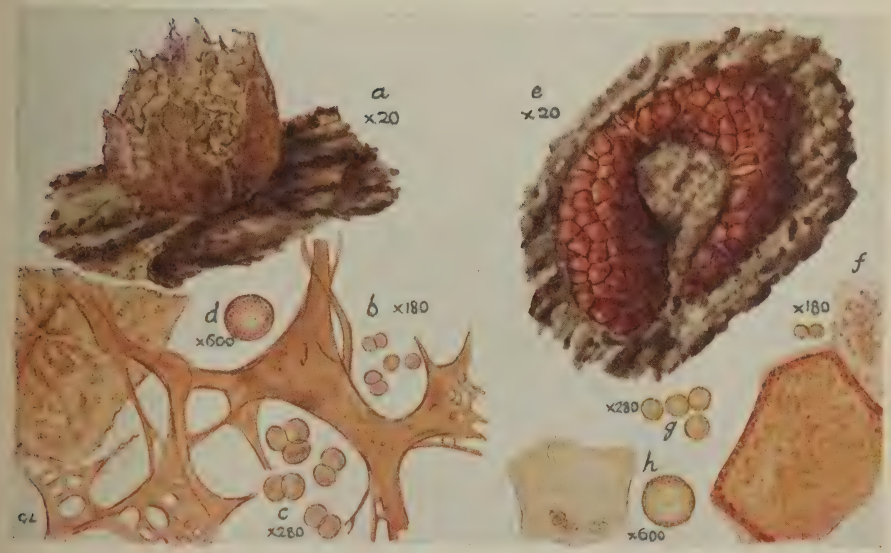


218. *a—e*, DIDYMIUM TRACHYSPORUM G. Lister
f—h, DIDYMIUM QUITENSE Torrend
k—m, LEPTODERMA IRIDESCENS G. Lister

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219. *a—d* CRIBRARIA FERRUGINEA Meylan
e—g LICEA CASTANEA G. Lister
h—k L. TENERA Jahn

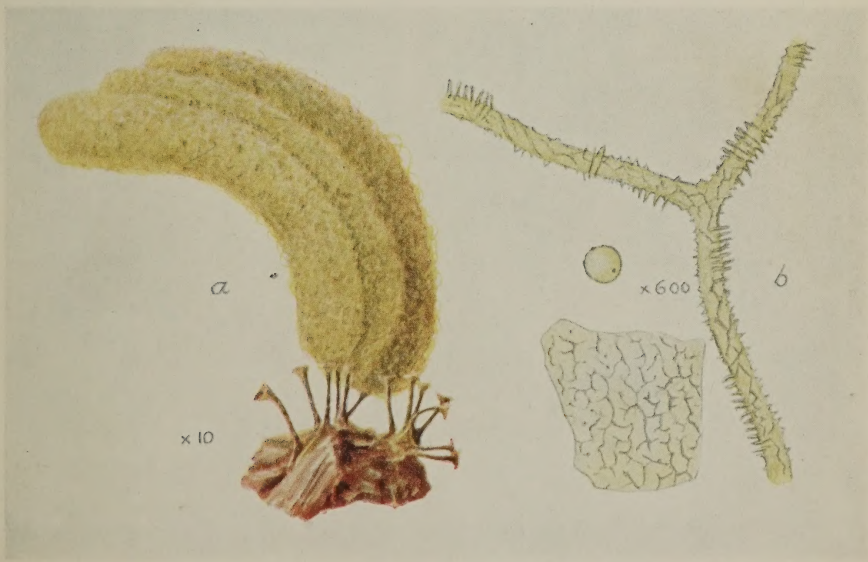


220. *a—d* ENTERIDIUM MINUTUM Sturgis
e—h PERICHÆNA QUADRATA Macbride

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221. DIDYMIUM FULVUM Sturgis



222. ARCYRIA VIRESCENS G. Lister

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3 0112 069455860